Sky and TELESCOPE

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In This Issue:

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... XIII, No. 4
...UARY, 1954

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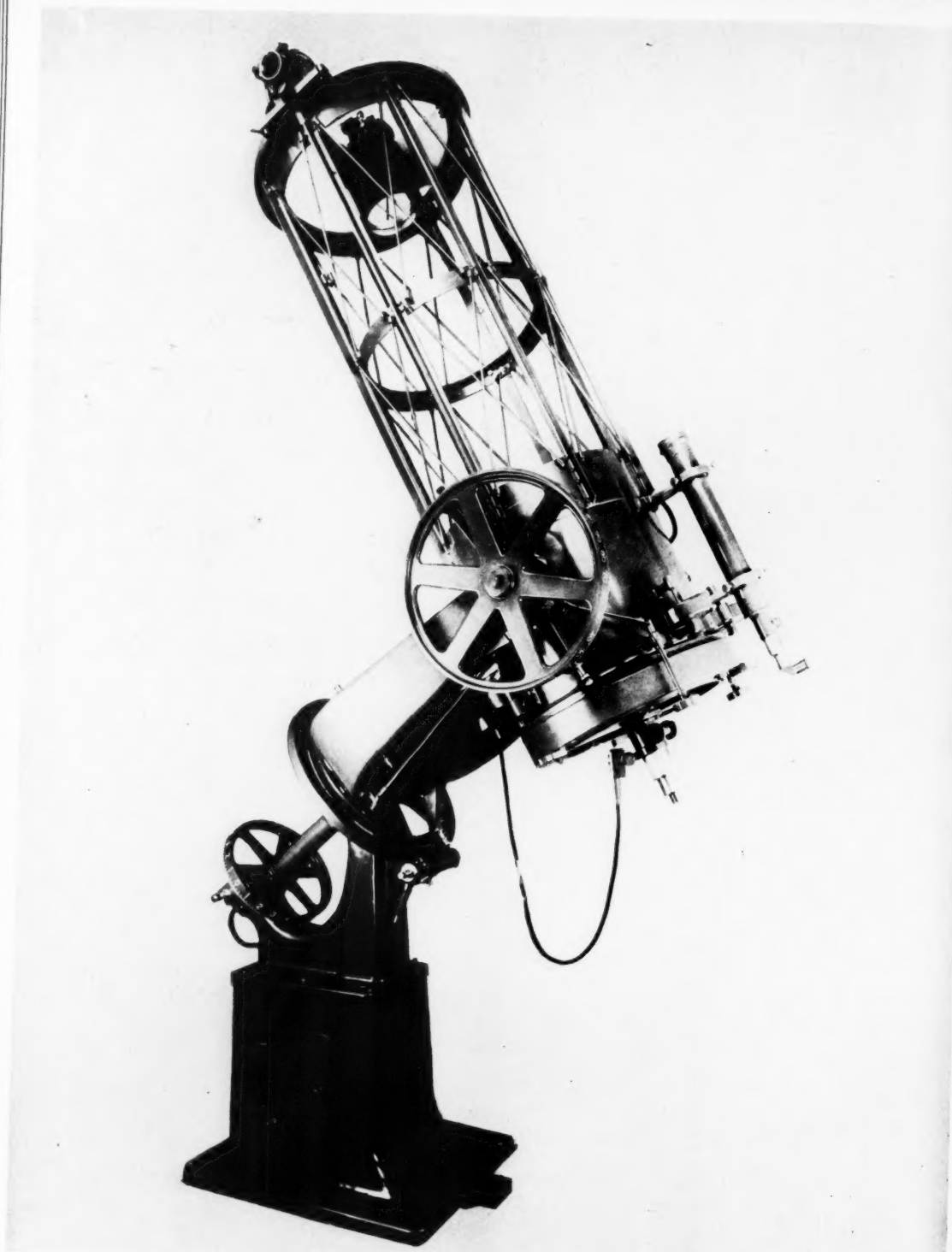
M. F. Lamont
(1911–1953)



24-inch Cassegrain-Newtonian Reflector

Designed and Manufactured by

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The Editors Note . . .

TEN YEARS AGO, beginning with our issue of May, 1944, Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, wrote a series of articles on the nature of cosmic rays, as it was known to scientists at that time. This series was reprinted in a pamphlet that has since been available to interested readers.

Now Dr. Swann has kindly fulfilled our request to write a new story, for tremendous strides have taken place in a single decade. The series begins in this issue.

CHANGES of location of interest to our readers involve a meteorite museum, a well-known amateur society, and a large reflecting telescope.

The new building of the American Meteorite Museum is in the village of Sedona, Ariz., on U. S. 89A, south of Flagstaff, at the lower end of Oak Creek Canyon. The meteorite collection of Dr. and Mrs. H. H. Nininger has been moved there from its old headquarters near Meteor Crater.

The building has 40 per cent more floor space, and is equipped with specially designed display cases. A monitor placard system, designed to serve science classes at all levels through college, shows at a glance where to find material bearing on any one of 25 meteoritical problems.

The American Association of Variable Star Observers transferred operations in January to a new home in Cambridge in Harvard Square. The society had been at the Harvard Observatory since its organization there in 1911.

The Solar Division has been reorganized, and the reduction of American sunspot numbers was brought up to date by a committee composed of Harry L. Bondy, Neal J. Heines, Mrs. Margaret W. Mayall, R. Newton Mayall, William A. Reid, David W. Rosebrugh, and Alan H. Shapley (see the Observer's Page).

Mrs. Mayall continues as recorder. All AAVSO and Solar Division correspondence should be sent to her at the new headquarters, 4 Brattle St., Cambridge 38, Mass.

The city lights and smog of the District of Columbia have proven an increasing handicap to the U. S. Naval Observatory's 40-inch reflector, which has been in operation since 1934. The Associated Press reports that the Congressional appropriations committees have approved spending $225,000 for the removal of this telescope to Flagstaff, Ariz., where observing conditions are many times more favorable. However, the authorization was still to be processed by the Department of Defense.

Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*
HELEN S. FEDERER, *Managing Editor*
JOSEPH ASHBROOK, *Assistant Editor*

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The new home of the Nininger collection of meteorites is located about as far south of Flagstaff as its former location was east of that city. Photo by Color West, Sedona, Ariz.

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COVER: One of the most versatile men of recent centuries, Mikhail Vasilevich Lomonosov (1711-1765) was famed as poet, astronomer, and chemist. His activities included inventing astronomical instruments, reforming the Russian language, and serving as secretary of state to Catherine the Great. This portrait, by an unknown artist, now belongs to the University of Moscow. (See page 118.)

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SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $4.00 per year in the United States and possessions; $7.00 for two years; $10.00 for three years. Add $1.00 per year for Canada and for all other foreign countries, including Latin America, making the total subscription $5.00 per year, $9.00 for two years, and $13.00 for three years. Canadian and foreign remittances should be made in United States currency. Single copies, 35 cents, foreign 45 cents. Circulation staff: Nancy R. Bolton, manager; Virginia K. Cox.

All notices of change of address must be sent one month in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, bearing adequate return postage, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts.

The principal articles in SKY AND TELESCOPE, beginning with Vol. XII, are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.

The Story of Cosmic Rays -- I

By W. F. G. Swann, *Director*
Bartol Research Foundation, Franklin Institute

THE STORY of cosmic rays had quite a humble beginning. It arose in connection with the power of the atmosphere to conduct electricity. The conducting power of the atmosphere is very small. A column of air one inch long offers as much resistance to the flow of an electric current as would a copper cable of the same cross-section extending from here to the star Arcturus and back 20 times over.

One might have thought that the central question would be why the conductivity of the air was as small as it was, rather than why it existed at all. However, even 50 years ago, our knowledge of how electricity is conducted through gases was becoming so definite that even the small conductivity of the air could not be ignored as too minute to be worthy of inquiry as to its origin.

It was realized that a gas could conduct electricity only by the motion of charged particles existing in it. We understood the nature of these charged particles, called ions. They are merely atoms of the gases in the air, but atoms that have become electrically charged by the removal of negative electricity from them or the addition of positive electricity to them. Study of the electrical structure of matter had revealed, even at that time, that all atoms contained negatively charged particles called electrons, which were more or less lightly bound to the atoms so that occasionally one was knocked off, leaving a positively charged atom. The electron which was knocked off, after wandering about for some time, could join partnership with a neutral atom, forming a negatively charged atom. These charged atoms, or ions, by their motion under electrical influence, served to transfer electricity from one place to another and to provide, therefore, for electrical currents.

Experiment confirmed the expectation that oppositely charged atoms would tend to come together by their mutual attraction, so that the extra electron that one possessed would be handed over to an atom that had lost an electron, with the result that the two atoms would once more be neutral and incapable of transporting electricity. To account for the continual presence of charged atoms, it was necessary to suppose the existence of some agency that would continually detach electrons from atoms. Such an agency was ready at hand in the radioactive materials in the atmosphere.

Atoms of radioactive substances are unstable and emit particles, some of them charged, with very great energies. Charged particles of such an origin, in traveling past neutral atoms, tend to dislodge electrons from them. The charged particle can steal an electron from an atom by attraction or hurl it out by repulsion, and rush ahead, leaving the electron far from its home, so that it is tempted to seek residence in the nearest of the neutral atoms around it; this gives rise to a negative ion, while the atom from which the electron had come is left as a positive ion.

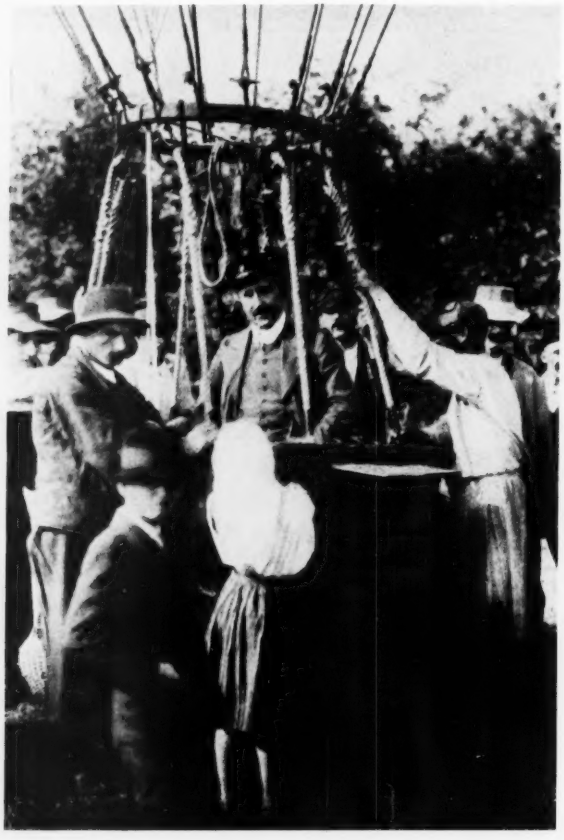
There are only about 28 grams of radioactive material in the atmosphere of the whole earth. But this was found sufficient to account for practically all of the ion production necessary to provide for the atmosphere's conductivity.

By filling a closed vessel with air that had been freed from radioactive material, investigators sought to ascertain whether or not ions were still produced in the air contained in the vessel. They found that indeed ions were present, to an extent comparable with 1/10 the rate of production of ions from the unpurified air. Naturally, for a long time uncertainty existed as to whether or not the residual ionization was due to radioactive contamination remaining in the purified air or existing in the walls of the containing vessel.

About 1911, the matter was conclusively settled in favor of a production of ions not attributable to radioactivity, when Victor F. Hess took a closed vessel of air up in a balloon and showed that the rate of production of ions in it increased very greatly with altitude. His discovery invited the assumption that there was some ionizing radiation coming into the atmosphere from above and diminishing in intensity through absorption as it penetrated deeper and deeper.

The simple concept of a single type of radiation entering the atmosphere and being responsible for the phenomena observed had to be modified as time progressed. The situation, as we have it today, is much more complicated.

To attempt a crude analogy, I shall invoke a picture of a large number of colonists entering a vast continent for the first time. As they establish themselves on the shores they must fight with the natives; the climate may not be healthy for the colonists and they do not succeed in penetrating very far into the continent. They may consist mostly of soldiers, but as time goes on their



The extraterrestrial origin of cosmic rays was first shown by the Austrian physicist, Victor F. Hess, when his measurements of their intensity during balloon ascents showed a steady increase with altitude. In 1910 he reached a height of 17,000 feet. Here Dr. Hess is seen as he landed from a flight in 1912. Later he came to the United States, and is now professor of physics at Fordham University.

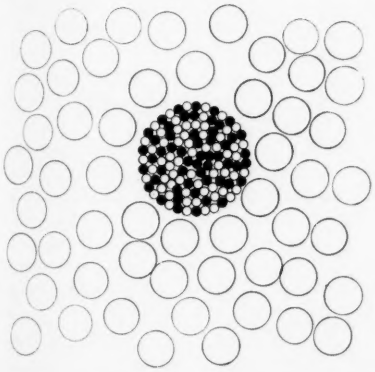
descendants may be quite different. Lawyers and preachers, doctors and pioneers, all sorts of beings come into existence as the fruits of the invasion and the turmoil. Some of these newly created people are able to travel farther into the continent than any of their ancestors had done before. Thus, the original colonists only start the work of penetration, and the other individuals who have come into existence through their efforts constitute the real invaders of most of the territory.

The above picture is in some respects illustrative of what we find in cosmic rays, the invading colonists representing *primary* cosmic rays. We now believe that these primary cosmic rays contain samples of practically all kinds of atoms in the universe, with the exception of some radioactive atoms whose lives would be too short to permit a journey of any distance through space.

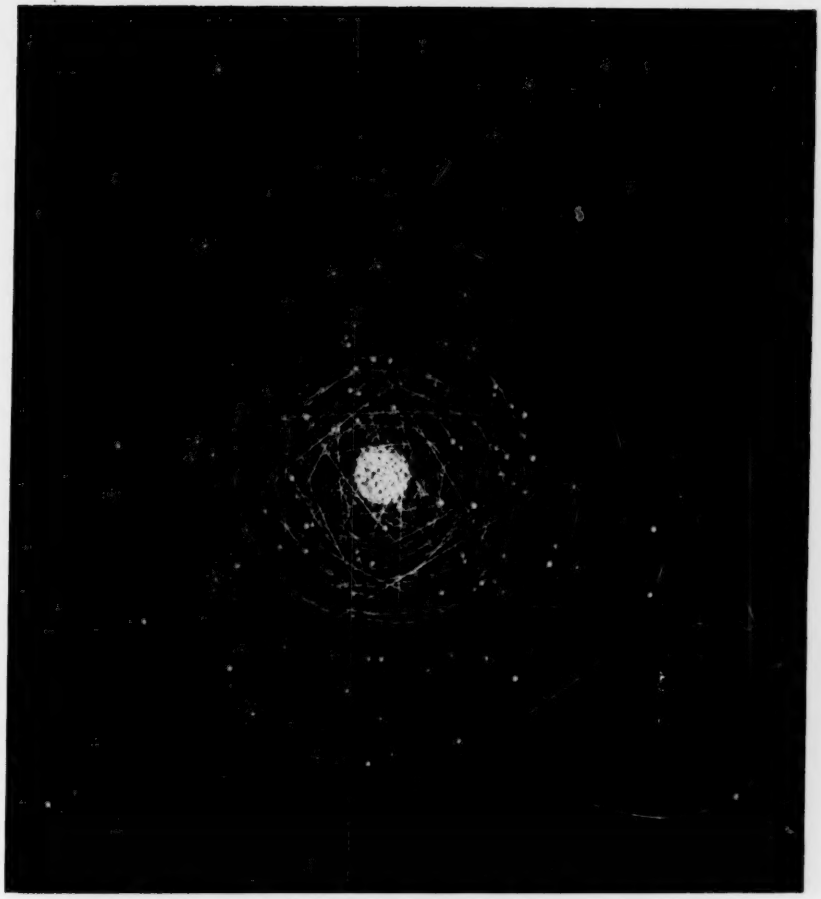
The primary rays are, for the most part, charged electrically and may have traveled for millions of years through interstellar space. The story of what happens when they enter the atmosphere is bound up closely with the properties of the constituents of atoms and of the atomic particles that play a part in the atom's activities. A discussion of these matters must form a prelude to our further examination of the cosmic rays themselves.

1. Atoms, and Elementary Particles

Atoms and Their Parts. The atoms of which the elements are composed are themselves built up out of three fundamental particles: the positively charged proton, the negatively charged electron, and the uncharged neutron. The lightest of these particles is the electron. The proton has a mass about 2,000 times as great and carries a charge equal and opposite to that of the electron. The neutron has a mass approximately equal to that of the proton.



In this representation of an atom, the black circles are protons; the small white circles are neutrons; and the large circles represent electrons. If the drawing were to the scale of the nucleus, the electrons would be about a third of a mile away.



This is a model of the uranium atom of atomic weight 235, built by Leigh Gibbs. The mathematical concept of ring electrons on specific orbits is shown, as well as the tightly bound nucleus. Boston Museum of Science photograph.

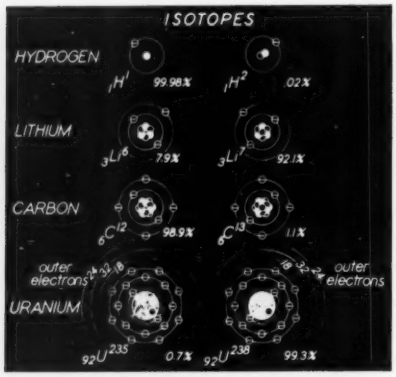
A typical atom has a core composed entirely of neutrons and protons. This nucleus contains practically all of the mass of the atom. Around the nucleus, at distances which are large compared with the very small dimension of the nucleus, are negative electrons equal in number to the protons in the nucleus. These electrons perform a kind of dance around the nucleus so that the whole structure is crudely analogous to the solar system with the sun at the center and its planets moving in the space around. The electrons are relatively loosely bound to the nucleus, but the particles in the nucleus itself are bound with enormously greater forces.

Hydrogen is the lightest of the elements, its normal atom composed of but a single proton with one electron attendant upon it. The next lightest atom is helium, which has two protons and two neutrons in its nucleus, with two electrons in the remote vicinity. The next lightest atom, lithium, has three neutrons and three protons in its nucleus, with three electrons in the space around. Proceeding in this manner to greater atomic weights, we find nuclei of increasingly large numbers of protons and neutrons, the electrons in a neutral atom being always equal in number to the protons. Roughly speaking, there are about as many neutrons as protons in the nucleus, although appreciable departures from this approximation are found over the range of the elements. Thus, for example, the atom of uranium that is responsible for fission in the atomic bomb has 92 protons and 143 neutrons in its nucleus.

Atoms can exist with the same number of protons but different numbers of neutrons. They are called isotopes, and are practically indistinguishable from one another by chemical test. It is the mutual interaction of the electrons between different atoms that is responsible for chemical affinity, and the electron structure is determined, both as regards the number of electrons and their general behavior, by the nuclear charge alone, that is, by the number of protons in the nucleus. The addition of a few neutrons to the nucleus has practically no effect upon the electron behavior.

In spite of this fact, however, the addition of neutrons to a nucleus may profoundly affect the stability of the

nucleus itself. A nucleus which is normally stable may become unstable, that is, radioactive, by change of its neutron content. Consider the atom of uranium 235, mentioned above. If an extra neutron enters this nucleus, the whole structure will blow up, with the formation of a number of lighter elements and the emission of a large amount of energy, as exemplified in the atomic bomb.



For isotopes of some common elements, the subscripts give atomic numbers and the superscripts indicate atomic weights. In each case the percentage shows the relative abundance of the isotope in samples of the element found in nature.

On the other hand, there is an isotope of uranium that has 146 neutrons in its nucleus; it is called uranium 238 and is 150 times more abundant than uranium 235. If it acquires an extra neutron, it becomes unstable in a relatively minor degree. It ejects an electron from its nucleus, so that it acquires by this act the equivalent of an extra proton and, in fact, it becomes another element — neptunium. This atom is again mildly unstable; it too will emit an electron from its nucleus to become a still different element — plutonium. This atom is fissionable, so that, on acquiring a still additional neutron it blows up completely into smaller atoms, with the emission of much energy which becomes evident in the atomic bombs made from plutonium.

A word must be said about an apparent paradox which appears in the foregoing discussion. We have remarked that a nucleus contains only neutrons and protons, and yet we have called upon it to emit an electron. How can it emit that which it does not have? In this matter, modern nuclear theory permits activities rather strange to the domain of man's common sense. It permits the taking of nothing (in the sense of zero charge) and dividing it into equal and opposite halves, one a positive charge which attaches itself to a neutron to create a proton, while the negative part in the form of an electron is ejected.

Subsidiary Elementary Particles. Although neutrons, protons, and negative electrons form the only permanent constituents of the atom, other particles come into existence during periods of drastic perturbation such as occur when a primary cosmic ray or one of its descendants strikes an atom of air.

First, we have a particle called the positron, which is the counterpart of the negative electron, having the same mass, but carrying an electric charge equal and opposite to that of the negative electron. Sometimes it is called a positive electron. The existence of positrons was first predicted by P. A. M. Dirac from purely theoretical considerations, before they were discovered experimentally in cosmic ray phenomena by C. Anderson.

Other important particles are the mesotrons, whose existence was also inferred on theoretical grounds by H. Yukawa from his studies of nuclear forces, and was afterwards confirmed by J. C. Street and by Anderson in cosmic ray experiments. The mesotrons are peculiar in the sense that they have but a finite life and die in due course without the intervention of any external agency.

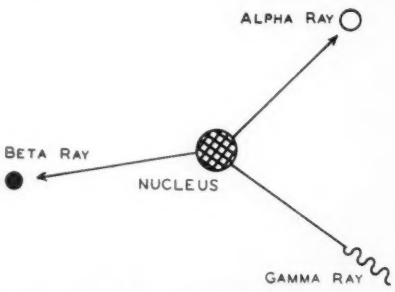
In this connection, a rather strange fact emerges. The theory of relativity teaches us that a particle which has a certain life expectancy, τ_0, when moving very slowly (strictly speaking, when at rest), has an increased life expectancy, τ, when in motion, where

$$\tau = \tau_0/(1-v^2/c^2)^{1/2},$$

in which v is used for the velocity of the particle and c is the velocity of light. When we speak generally of the *mean life* we refer to τ_0, which is the time for any given number of resting mesotrons to diminish to about one third of their original number (strictly speaking, to $1/e$ of their original number, where e is 2.718 . . ., the base of the natural system of logarithms).

When the mesotrons were first discovered, it was thought that they were all of one kind, but as knowledge has advanced, it now appears that there are several kinds, which are in part related to one another like child and parent, or brother and sister. When a proton of high energy enters our atmosphere, collisions with the atoms of the air result in the proton's disintegration and the formation of mesotrons which are, as it were, born from its ashes. When a heavy atom enters the atmosphere, its individual protons suffer a similar fate, with the resulting production of mesotrons. The neutrons of the atomic nuclei seem to be preserved from a like fate, but they are not completely immune, because a neutron freed from its home in an atomic nucleus sacrifices its right of permanent existence and dies after a period of about 13 minutes.

Next month we shall return to a fuller discussion of the individuals of the mesotron family.



The particles released by disintegration of an atomic nucleus are shown here schematically. Alpha rays are positively charged helium nuclei, moving at about 1/10 the velocity of light; beta rays are negative electrons with nearly the speed of light; and gamma rays are photons of light of very high energy.

In phenomena of the kind we are discussing, another particle has entered the picture, the neutrino. Its presence has only been inferred, never observed in the ordinary sense of the word. As is well known, physicists place great faith in the conservation of energy and momentum in atomic processes. However, it appears that in some of these processes, adding up all the contributions of the various particles to the energy after the occurrence in question gives a sum less than that obtained by adding up the various contributions before the occurrence. And so the concept of the neutrino was invented to play the role of the thief who stole the energy. The neutrino has never been known to do anything but own energy, and just as it is very difficult to apprehend an ordinary thief who never spends any of his stolen money, so it has been very difficult for science to place its finger upon this neutrino and say: "Ha, I have caught you in the act," because the neutrino appears to have no act.

Photons. The term photon is used to characterize all of those particles that are associated with wavelike properties. In particular, it comprises ordinary light rays, ultraviolet rays, X-rays, and the so-called gamma rays from radium.

There was a time when these radiations were thought to be of a wave nature, the wave concerned spreading out into space from the place of origin with ever-decreasing intensity. The shortest waves were those associated with gamma rays, the X-rays were somewhat longer, about one 1,000-millionth of a centimeter in wave length. Then came the light waves, some 50,000 times longer, and finally the category extended down even to radio waves.

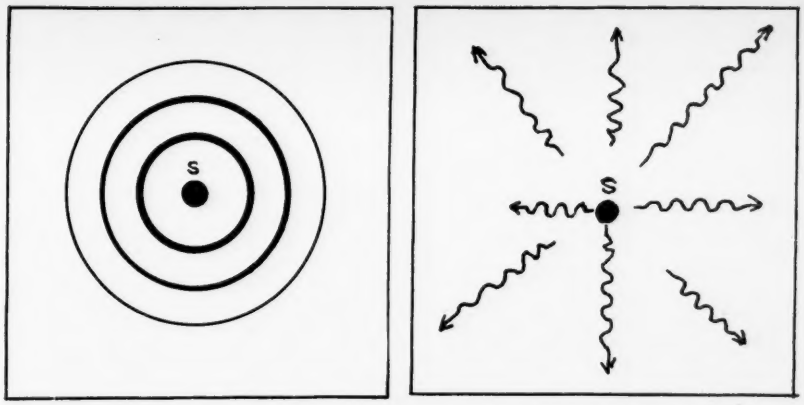
Early in the present century, radiations of this type began to present a great puzzle to the student of physics. In some respects the radiations acted like waves, as already stated, but in others they acted like particles. Perhaps

the most drastic illustration of the paradox was in interference phenomena, such as occur in a very understandable manner when water ripples are reflected from an obstacle; the reflecting ripples interfere with oncoming ripples to produce definite patterns resulting from collaboration of the incident and reflected ripples in certain places and cancelation in other places.

The concept of spreading waves is inevitably bound up with diminution of the wave's intensity with distance from the point of its origin. On the other hand, the radiations we have classed as photons, while exhibiting wavelike characteristics in certain phenomena, masquerade in other instances like bullets shot from a gun. Apart from effects resulting from the resistance of the medium, such a bullet is just as potent after traveling 100 yards as it is after one yard. In the case of a battery of such guns firing in all directions from a fort, the chance of getting hit would diminish with the distance from the fort. But if one did get hit, he would be just as dead if hit at half a mile as he would be if hit at 100 feet.

The mathematical physicist has formulated his ideas and theories in such a manner that he is not disturbed by the apparent paradox in the coexistence of the bulletlike properties and wavelike properties, but he has not succeeded in presenting them in such a form as to give contentment to the layman. Fortunately for our purpose, these matters need not cause us serious trouble. It will suffice for us to think of these radiations, which in the aggregate we have called photons, as particle-like in nature; they differ in energy, however, not by the normal differences of velocity, but by some other characteristics customarily associated with definite frequencies of vibration. In other words, their velocities are all the same (in a vacuum), and their frequency of vibration determines their energy content.

(To be continued)



These sketches illustrate the two concepts of the nature of light. At the left, waves diminish in intensity as they spread from a source; at the right, wavelike particles retain their energy as they travel outward.

LETTERS

Sir:

Considering the number and great variety of readers that **Sky and Telescope** attracts, the wide scope of the material presented in it is quite justified. It is therefore very important that all the information given be scientifically correct, since every item will find some reader whose interest it will have to satisfy.

I wish to call attention to an incorrect explanation of the relativistic advance of the perihelion of Mercury's orbit given on page 312 of the October, 1953, issue. This advance cannot be explained, as stated there, by the change of Mercury's mass due to change in velocity (which is, by the way, a consequence of the restricted or special theory of relativity), but it is directly explained by the general theory of relativity.

This theory is abstract and mathematical, and it is very difficult to express its consequences in common language. The difficulty is not a valid argument against the theory, as many people think; many things difficult to explain are nevertheless very correct, as, for instance, atomic energy.

Let us consider, in a very brief and general form, the advance of Mercury's perihelion according to the general theory of relativity. The structure of space, or rather of the space-time continuum, is determined by the presence and amount of matter in the universe. In other words, the laws of geometry that we find in nature by measuring distances and lengths are as they are and not otherwise because there exists a certain amount of matter in the universe. These geometrical laws, by determining the structure or properties of space, also constitute the rules according to which celestial bodies will move when they are near each other. On the other hand, according to the older Newtonian theory celestial bodies move due to a certain property of matter that we call the force of gravitation.

In the general theory of relativity, the geometrical properties of space take the place of the force of gravitation; and when a body moves in a certain way it is, according to the new theory, just the **natural behavior** of the body due to the structure of space in the place where that body is located. It is possible, on the basis of general relativity, to calculate the structure of space in the vicinity of our sun and so to find the natural behavior of the planets, in other words, their orbits.

When this is done, it is found that the motion of the planets predicted by relativity theory is, within the limits of observational accuracy, indistinguishable from the motion predicted by the theory of gravitation—for all planets except Mercury. That planet shows a difference between the two theories amounting to 43 seconds of arc per century in the movement of the planet's perihelion. Furthermore, there is a difference of precisely the same amount between the observed movement of Mercury and the prediction by Newtonian gravitation. In other words, 43 seconds exist in the movement of Mercury's perihelion that divorce it from Newton and bring it into agreement with the general theory of relativity.

This discrepancy cannot be accounted for by computations based on the assumption of a "force of gravitation," but it is accounted for as a natural consequence of the new assumption that the motion of a planet is not caused by any special force. It is just the natural behavior of the body in a space whose geometrical properties are determined by the presence of material bodies in it.

BORIS JASKOVICH
National Observatory
Havana, Cuba

Sir:

I recently came back from a study tour of the Pacific, especially Micronesia, where I taught stars to the youngsters at the Seventh Day Adventists' missions in Guam and at Koror in Pelau. These missions are most anxious to have small portable telescopes and some good popular astronomical books. Has any of your readers a telescope not in use, and would he give it to the little brown children of Micronesia, our wards in the Pacific? Star charts and copies of good popular texts would also be welcome. Send them to the undersigned; we will pay all freight and insurance charges to the islands. Or a donation of $1.00 or more will help us buy needed material.

Dr. C. G. Oliver, missionary on Guam, is from Oregon, and his wife is from Michigan. Pastor Jack Bowers, at Koror, is a Texan. Mrs. Bowers was born in China, daughter of foreign missionaries. Donations from their home states, or from anywhere in the United States, will encourage astronomy in these islands, which we administer as trustees for the United Nations.

MARIBELLE CORMACK
Roger Williams Planetarium
Providence 5, R. I.

NEWS NOTES

By Dorrit Hoffleit

TWO-COLOR COMPOSITE PICTURES OF GALAXIES

In the *Griffith Observer* for December, Dr. F. Zwicky, Mount Wilson and Palomar Observatories, describes the manner in which he has superimposed blue and yellow-green photographs of galaxies and other objects to reveal the distribution of stars and nebulae of different colors. The method is similar to that which has been used in the past for variable star and proper motion work, with the negative of one exposure superimposed on a positive transparency of the other.

His illustrations for the spiral galaxy NGC 6946 show clearly that blue supergiant stars appear mostly in the outer parts of the spiral arms, while the central regions of the system are predominantly red. The superimposed photographs in two colors thus reveal almost at a glance information that has previously been obtained from detailed measurements and intercomparisons.

Dr. Zwicky finds from pictures of this kind that there are basically at least four types of stellar populations, instead of two. He has discovered a great number of very faint blue stars on the outskirts of the Milky Way galaxy near the north galactic pole. He believes that "this system as well as most other galaxies have very tenuous outskirts which extend far into intergalactic space until they meet the outskirts of the neighboring galaxies. There appears to exist no truly empty intergalactic space and its total population, although sparsely distributed, may contribute a sizable proportion to the total mass of large regions in the universe."

VIBRATING CAMERA FOR METEOR OBSERVATIONS

A new method of photographing meteors is described in the *Irish Astronomical Journal* by Dr. E. J. Opik, of the Armagh Observatory. His camera is an outgrowth of a device he used 20 years ago for the visual measurement of meteor velocities; then the observer viewed the reflection of the meteor in a mirror rocking conically 10 times a second.

The new camera, of 7-cm. aperture and 20.6-cm. focal length, is given a small conical motion around its optical axis, at 1,000 revolutions per minute. The camera is otherwise fixed, and during the exposure the stars form widened trails, brighter on their outer edges. Meteors, because of their rapid motion, show on the photograph as epicyclic curves with bright cusps. The positions of these cusps are easily measured to yield accurate angular velocities.

Dr. Opik claims several advantages over the more commonly used technique of a rotating shutter in front of the objective of a camera driven to follow the stars. The enhancement of the cusps enables fainter meteors to be photographed. Since the camera is fixed with respect to the horizon (apart from the vibration), geocentric velocities can be determined without knowing the exact time of appearance of the meteor, provided the star trails are marked at known moments of time. The heliocentric velocity is not so well determined as when the time is known, but for upper-atmosphere studies geocentric velocities are more important.

JUPITER AND SUNSPOTS

A correlation between the appearance of spots on Jupiter and solar flares was found a year ago by Dr. Yale Mintz at the Lowell Observatory, working under an Air Force Cambridge Research Center contract (*Sky and Telescope*, March, 1953). This research had been inspired by previous indications of relations between solar flares and terrestrial upper-atmosphere phenomena.

From visual observations, A. S. Williams had earlier concluded that Jupiter's north and south equatorial belts alternated in relative conspicuousness, in about the period of the sunspot cycle.

Now, in the October *Journal of Meteorology*, Ralph Shapiro, associated with the same institutions, has published a study based upon photographs of Jupiter taken at the Lowell Observatory during the past 50 years. Since 1926 these photographs have been on plates calibrated for accurate photometric work.

What Dr. Shapiro measured was the brightness of Jupiter's equatorial zone in terms of the brightness of other Jovian latitude zones. He finds that the equatorial zone is relatively brighter, both in blue and yellow light, in the years when sunspots are infrequent. He speculates that variations in the ultraviolet solar radiation may trigger some mechanism within Jupiter's atmosphere which ultimately gives rise to the observed changes in relative brightness.

COPERNICAN MANUSCRIPT RETURNS TO POLAND

After 400 years the manuscript of Copernicus' *De Revolutionibus Orbium Coelestium Libri VI* has returned to the place of its origin. In tribute to Copernicus and his country on the 410th anniversary of his death, Czechoslovakia presented the manuscript to Poland during the commemorative meetings of the Polish Academy of Sciences.

When its first editor, Georg Joachim Rheticus, of Wittenberg University, died in 1576, the manuscript went to Valentin Othon, at Heidelberg University, and later to the dean of the university, named Christmann. Upon the latter's death, it was sold to a scientist in Czechoslovakia, Jara Amos Komensky. From about 1640, the document was kept there in the library of the Nostitz counts. At present it is on display in the Polish national museum at Warsaw.

"METEORITICS"

The first number of a new journal, *Meteoritics*, has just appeared, published jointly for the Meteoritical Society and the Institute of Meteoritics of the University of New Mexico. It is edited by Dr. Frederick C. Leonard, of the University of California at Los Angeles, and the associate editor is Dr. Lincoln LaPaz, director of the Institute of Meteoritics. The first issue, of 123 pages, contains 24 papers on many aspects of this broad field.

Since the cessation of *Popular Astronomy* in 1951, there had been no regular medium for the publication of papers by those engaged in research on meteorites. Also, the American Meteor Society now has a place for reports of meteor observations by its members and other observers.

A most appropriate discussion by Dr. Leonard, "Recent and Future Developments in Meteoritics," compiles the opinions of experts and lists 50 problems whose solution or elucidation will require further research. Other articles are on the photography of high-speed jets, the formation of craters by high-speed particles, pre-atmospheric geocentric velocities, the possible occurrence of meteoric nickel in ancient Asiatic coins, and equipment for slicing meteorites.

This issue of *Meteoritics* may be purchased by nonmembers of the Meteoritical Society for $4.00, from the University of New Mexico Press, Albuquerque.

KENTUCKY METEORITE FALL

On September 20, 1950, a fireball brighter than the full moon was observed from half a dozen states as it passed southward over Illinois into Kentucky. When it exploded at a height of more than 45 kilometers, the sound was heard and windows were rattled over an area of 1,000 square miles. About 30 seconds later fragments were heard thudding into the ground in Calloway County, Ky., about nine miles east of Murray.

The fall, described in *Meteoritics* by John R. Horan, of the American Cyanamid Company, was investigated by a group from Vanderbilt University, under the leadership of Dr. Carl K. Seyfert. Rains handicapped the search and only a few pieces were recovered, some separated by as much as three miles. The largest fragment, 15 centimeters in diameter, had been heard falling into a hard-beaten path just 26 feet from a residence; another went through the roof of a house, but did not penetrate the floor.

Dr. Charles P. Olivier, president of the American Meteor Society, computed

the orbit of the fireball, while Dr. Horan (then at the Oak Ridge National Laboratory) examined the physical and chemical properties of the meteorite fragments, which together weighed seven kilograms. The meteorite has a higher-than-normal carbon content, two per cent, but not an unprecedented amount. The Murray, Kentucky, aerolite is classified as a carbonaceous chondrite.

The velocity, from uncertain observational data, appears to have been hyperbolic, 71 kilometers per second, but Dr. Olivier assumed the orbit to be parabolic. Further search for fragments might be profitable now that the trajectory in the atmosphere is known. It is possible, however, that part of the mass may have fallen into Kentucky Lake, farther to the east of Murray.

ROBERT ANDREWS MILLIKAN

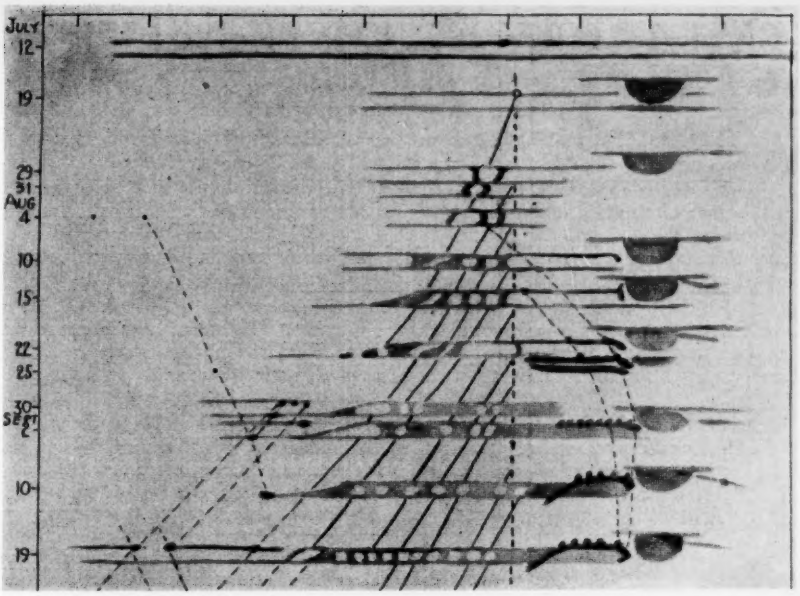
With the death of R. A. Millikan on December 19th, America has lost one of its most outstanding physicists. Nobel physicist for 1923, in his long life (85 years) Dr. Millikan contributed a great deal of fundamental research, especially on the nature of the atom and cosmic rays. For his work, he received a score of prizes and medals from scientific organizations all over the world.

He was also interested in the furtherance of understanding of the sciences by the public. He became one of the original trustees and incorporators of Science Service, Washington, D. C., and served actively on its board of trustees ever since its inception in 1921.

JOVIAN ATMOSPHERE

Observations of the occultation of Sigma Arietis by Jupiter on November 20, 1952, made with a photoelectric photometer attached to the 60-inch Mount Wilson reflector, have enabled Dr. W. A. Baum, Mount Wilson and Palomar Observatories, and Dr. A. D. Code, Washburn Observatory, to make some significant deductions on the composition of Jupiter's atmosphere. When Jupiter passed in front of the star, it took the latter 10 seconds to disappear completely.

This observation can be interpreted in terms of the mean molecular weight of Jupiter's atmosphere. For instance, if the atmosphere had consisted entirely of methane, the star would have faded out in one or two seconds. The calculations by Drs. Baum and Code yielded a mean molecular weight of about 3.3. From this they infer that helium and hydrogen account for the bulk of the planet's upper atmosphere. The observations are not capable of revealing in what percentages the other elements are present. They do not contradict earlier findings that methane and ammonia occur in Jupiter's atmosphere, as relatively small amounts of these gases will account for the appearance of Jupiter's spectrum.



Part of a drawing by R. A. McIntosh, of a series of bright spots in the south equatorial belt of Jupiter in 1949. The Jovian longitude runs horizontally, beginning with 280° on the left, and marked at 40-degree intervals around the planet. The vertical dotted line marks longitude 163° at which each of the bright spots made its first appearance. The great red spot is at the right, in longitude about 240°. Some dark spots, possibly related to the system of bright spots, are also included. Reproduced from the "Journal" of the British Astronomical Association.

ROTATION OF THE NUCLEUS OF JUPITER

A possible method for determining the period of rotation of the solid core of Jupiter is outlined by E. J. Reese, of Uniontown, Pa., in the *Journal* of the British Astronomical Association. All previous determinations of Jupiter's rotation period refer only to the planet's atmosphere. It has been proposed that the great outbreaks of spots seen on Jupiter from time to time are due to volcanic activity. The erupted material would tend to drift across the surface, but the *initial* locations of the outbursts should eventually reveal the rotation period of the solid nucleus, as pointed out by W. H. Haas, of the Association of Lunar and Planetary Observers.

In 1949, for instance, on July 19th, R. A. McIntosh saw a small bright spot the apparent size of a satellite but much brighter appear in the south equatorial belt. Ten days later it had expanded to fill completely the space between the two components of the belt and to extend over 10 degrees of longitude. On August 4th a second spot appeared, with the same relative velocity in longitude as the first spot. "Thereafter," states Mr. McIntosh (BAA *Journal*, October, 1950), "further bright spots totalling at least 20 continued to form in the longitude of the original eruption and to follow one another along the belt like pearls on a string." A portion of his drawing of the appearance of these spots and associated features on Jupiter is reproduced here.

Using observations of seven outbreaks of spots in the south equatorial belt in 1919-52, Mr. Reese finds two possible periods, $9^h\ 54^m\ 52^s.54$ and $9^h\ 55^m\ 42^s.66$. The longer, which he provisionally favors, would imply the existence of two volcanoes in the same latitude, but 90 degrees apart in longitude. The predicted and observed locations of the supposed volcanoes at their various reappearances then agree to within about 10,000 kilometers. In an appendix to the article, Bertrand M. Peek points out that this discrepancy seems larger than the errors of observation and suggests that the sources of the outbreaks may be extended areas of volcanic activity rather than single volcanoes.

IN THE CURRENT JOURNALS

SCIENCE AND MODERN COSMOLOGY, by H. Dingle, **Monthly Notices,** Royal Astronomical Society, Vol. 113, No. 3, 1953. "The universe we contemplate today is no longer the observable world that for 2000 years was the sole object of astronomical study; it is a hypothetical entity of which what we can observe is an almost negligible part."

THE DISTRIBUTION OF LIGHT IN GALAXIES, by Gerard de Vaucouleurs, **Leaflet** No. 296, Astronomical Society of the Pacific, December, 1953. "Apparent dimensions of spiral and elliptical nebulae, as measured directly on photographic plates, are a most unreliable indication of the real extension of these outer galaxies."

MERCURY TRANSIT -- THE CONTACT TIMES

By JOSEPH ASHBROOK, *Harvard College Observatory*

ASTRONOMERS use observed contact times of transits of Mercury for investigating fluctuations in the earth's rate of rotation and for improving the orbit of Mercury. In the October *Sky and Telescope,* a request was published for observations of contact times of the November 14th transit, and instructions to observers were given, based on those issued by the U. S. Naval Observatory in 1940. The response to this appeal was excellent; from the wealth of material received, the data of the following tables has been extracted. The average times given here for contacts II and III are preliminary. A detailed analysis will be submitted to the *Astronomical Journal.*

No useful information can be deduced for contact I, as when Mercury is first recognized as a notch in the sun's edge the actual contact is already well past.

The weighted average of the 65 observations of contact II included in the table indicates that it took place, as seen from the center of the earth, at 15:40:39 Universal time, with an uncertainty of about three seconds. This is two seconds earlier than the prediction of the *American Ephemeris.*

Contact III, from 75 observations, occurred at 18:06:42, with an uncertainty of about four seconds. This is 29 seconds earlier than predicted. This striking discrepancy is similar to that of the November 11, 1940, transit, which was perhaps the most intensively observed transit of Mercury on record, when the duration was also much shorter than expected.

There is no satisfactory explanation of these anomalies; according to G. M. Clemence, director of the Nautical Almanac Office, the 1940 result cannot be accounted for by any reasonable corrections to the assumed orbit of Mercury, or to the adopted diameters of the planet or the sun. It is obvious that the slow fluctuations in the earth's rotation would affect all contacts in the same way, and so could not account for the 27-second deficit in the duration of the 1953 transit.

The spread in the 49 observed times of contact IV is considerable, for evidently observers with large telescopes and good seeing were able to follow longer the last dwindling notch made by Mercury on the sun's limb. The average of the five latest geocentric times for contact IV is 18:10:35, which is 13 seconds earlier than the *American Ephemeris* time.

The large table lists all the observers' locations, in order of longitude. Limitations of space do not permit the listing of the names of timers and assistants,

No.[1]	Place	Long. west ° ′	Lat. north[2] ° ′	Observer	Telescope[3]	Remarks
1	Resistencia, Argentina	58 59	−27 27	A. Romana	9M, 150x	
2	Trinidad, B.W.I.	61 36	10 41	F. C. Baird	4L, 200x	
3	Nantucket, Mass.	70 06	41 17	M. Harwood	5L, P6, Maria Mitchell Obsy.	
4	Milton, Mass.	71 04	42 15	A. Oliver, Jr.	5½L, P13, Stearns Obsy., Milton Acad.	
5	Milton, Mass.	71 04	42 15	H. C. Stubbs	5½L, P13, Stearns Obsy., Milton Acad.	
6	Milton, Mass.	71 04	42 15	H. H. Thayer	5½L, P13, Stearns Obsy., Milton Acad.	
7	Cambridge, Mass.	71 08	42 23	J. H. Knowles	7½L, 100x, Harvard Obsy.	
8	Weston, Mass.	71 17	42 22	J. Ashbrook	3L, 100x	
9	Los Angeles, Peru	76 45	−11 58	J. C. Mendivil	3L, P10, Asociacion Peruana de Astronomia	
10	Los Angeles, Peru	76 45	−11 58	V. Estremadoyro	2L, P8, Asociacion Peruana de Astronomia	
11	Washington, D. C.	77 00	38 51	L. Secretan	2½L, 85x	
12	La Plata, Md.	77 07	38 24	L. T. Johnson	10M, 300x (7½M, 178x, at egress)	
13	Richmond, Va.	77 25	37 34	T. J. Ogburn, III	4L, 160x	
14	Richmond, Va.	77 26	37 34	B. S. Ragland	4L, 100x, T. W. Stone's Obsy.	
15	Rochester, N. Y.	77 33	43 07	P. W. Stevens	1½L, 70x	
16	Rochester, N. Y.	77 33	43 07	A. Dounce	6M, P7	
17	Rochester, N. Y.	77 33	43 07	G. Milne	?	
18	Rochester, N. Y.	77 37	43 14	W. Hollingsworth	3L, 40x	
19	Chimbote, Peru	78 35	− 9 05	G. Estremadoyro	3L, P8, Asociacion Peruana de Astronomia	
20	Broadway, Va.	78 48	38 38	L. Dove	4L, P9	
21	Gatun, C. Z.	79 36	9 00	A. A. Albright	5L, P4, Miraflores Obsy.	
22	Greensboro, N. C.	79 52	36 06	Several	4L, P9, Greensboro Ast. Club	
23	Pittsburgh, Pa.	80 00	40 27	L. J. Scanlon	6M, 128x, AAA of Pittsburgh	
24	Pittsburgh, Pa.	80 00	40 27	C. H. LeRoy	6M, 128x, AAA of Pittsburgh	
25	Maple Heights, O.	81 33	41 25	K. L. Walko	8M, P26	
26	Elyria, O.	82 07	41 21	J. Rick	6M, P, Black River Ast. Soc.	
27	Elyria, O.	82 07	41 21	G. Diedrich	6M, P, Black River Ast. Soc.	
28	Elyria, O.	82 07	41 21	A. Goldstein	6M, P, Black River Ast. Soc.	
29	Lorain, O.	82 09	41 29	P. W. Smith	4L, 100x	
30	Gambier, O.	82 24	40 22	F. Miller, Jr.	5L, P10, Kenyon College	
31	Gambier, O.	82 24	40 22	T. Barker	5L, P10, Kenyon College	
32	Gambier, O.	82 24	40 22	C. Criss	5L, P10, Kenyon College	
33	Gambier, O.	82 24	40 22	K. Jewell	5L, P10, Kenyon College	
34	Ann Arbor, Mich.	83 44	42 17	W. Liller	12L, P26, Univ. of Mich. Obsy.	
35	Ann Arbor, Mich.	83 44	42 17	E. B. Weston	12L, P26, Univ. of Mich. Obsy.	
36	Griffin, Ga.	84 16	33 15	P. O. Parker	4L, 60x	
37	Decatur, Ga.	84 17	33 47	W. H. Close	16M, 52x	
38	Decatur, Ga.	84 17	33 47	J. L. Brown	6M, 144x (only 38x at ingress)	
39	Decatur, Ga.	84 18	33 46	W. A. Calder	6M, 40x, Bradley Obsy.	
40	Decatur, Ga.	84 18	33 46	F. P. Rose	10M, 120x	
41	Cincinnati, O.	84 43	39 12	A. K. Presnell	8¼L, 120x, Cincinnati Ast. Soc.	
42	Cincinnati, O.	84 43	39 12	J. Cartlidge	4L, 80x, Cincinnati Ast. Soc.	
43	Gas City, Ind.	85 36	40 25	J. M. Spooner	10M, 160x	
44	Panama City, Fla.	85 39	30 09	N. K. McKinnon	8M (stopped down to ¾ inch)	
45	Coral Ridge, Ky.	85 47	38 08	L. P. Aker	8M, 108x	
46	Chicago, Ill.	87 36	41 50	H. B. Beidler	5L, 150x	
47	Mt. Vernon, Ind.	87 53	37 57	W. B. Challman	1¾L, 20x	
48	Milwaukee, Wis.	87 58	43 10	R. R. Fink	6M, 96x, Milwaukee Ast. Soc.	
49	New Berlin, Wis.	88 09	42 58	J. S. Neff	4L, P6, Milwaukee Ast. Soc.	
50	Urbana, Ill.	88 14	40 06	S. P. Wyatt, Jr.	12L, 129x, Univ. of Ill. Obsy.	

even though these played a vital part in the success of the program.

The remaining tables list the observed times for each contact. In the first column, each observer is identified by the number assigned to him in the large table. The second column gives the Universal time, as reported by the observer. To reduce this time to that which would correspond to an observer at the center of the earth, the correction listed in the third column must be applied; this has been computed with the aid of the formulae at the foot of page 364 of the 1953 *American Ephemeris*. Adding this correction to the observed time gives the geocentric time, listed in the fourth column. It is these geocentric times which can be directly intercompared.

The residual $O-C$ (observed minus computed) is the observer's geocentric time minus the geocentric time predicted in the *American Ephemeris*.

The symbol T is used when the observer's remarks indicate that true contact was observed, rather than apparent tangency of Mercury and the sun. By true contact is meant that the thread of light formed, or that the black drop broke, at the recorded moment for contact II, and correspondingly for contact III. Cases where the report specifies that no black drop occurred are also designated by T, and the letter t includes the above and indicates the additional circumstance of poor seeing. When true contact is not specified, poor seeing is denoted by u.

The tables omit the few observations for which so little detail was reported that reasonable care on the observer's part could not be assured. In particular, no time is listed here that did not depend on WWV time signals or their equivalent. A few highly discordant times that were obviously in error by several minutes have not been used.

Many of the observers' reports contained interesting and useful remarks on equipment and observing techniques, and on phenomena such as the black drop. These statements have been summarized in the general story on the transit which was published in the January issue, page 75.

Sky and Telescope extends its thanks to the many persons who helped as observers, timers, recorders, and reporters in this very successful transit of Mercury program.

CONTACT II

No.	Obs. time h m s	Red'n. s	Geoc. time h m s	O − C s	
1	15 40 48	−11	15 40 37	−04	
2	40 21	+24	40 45	+04	T
4	40 13	+39	40 52	+11	
5	40 09	+39	40 48	+07	
6	40 18	+39	40 57	+16	
7	39 40	+39	40 19	−22	T
8	39 55	+39	40 34	−07	T
9	40 11	−18	39 53	−48	
10	40 36	−18	40 18	−23	
11	39 46	+31	40 17	−24	T
12	15 40 08	+31	15 40 39	−02	T
13	40 17	+29	40 46	+05	T
14	40 14	+30	40 44	+03	T
20	40 18	+29	40 47	+06	
21	40 00	00	40 00	−41	u
23	39 57	+29	40 26	−15	
25	40 08	+29	40 37	−04	
27	40 31	+28	40 59	+18	
29	40 24	+28	40 52	+11	u
34	39 56	+28	40 24	−17	T
35	15 39 50	+28	15 40 18	−23	T
36	40 27	+19	40 46	+05	
38	40 30	+19	40 49	+08	
39	40 16	+19	40 35	−06	u
41	40 13	+24	40 37	−04	
42	40 14	+24	40 38	−03	
43	40 16	+24	40 40	−01	

No.[1]	Place	Long. west ° ′	Lat. north[2] ° ′	Observer	Telescope[3]	Remarks
51	Wauwatosa, Wis.	88 30	43 36	E. B. Heckenkamp	8M, 123x	
52	Rockford, Ill.	89 07	42 17	C. C. Taylor	16M, P15	
53	St. Louis, Mo.	90 14	38 38	E. M. Brooks	3L, P10, St. Louis Amateur Ast. Soc.	
54	St. Louis, Mo.	90 14	38 38	J. Boyd	3L, 80x, St. Louis Amateur Ast. Soc.	
55	St. Louis, Mo.	90 14	38 38	S. L. O'Byrne	3¼L, 165x, St. Louis Amateur Ast. Soc.	
56	St. Louis, Mo.	90 18	38 39	W. Rutter	5L, P9½, Washington Univ.	
57	Norwalk, Wis.	90 39	43 56	C. E. Ott	6¼M, 60x	
58	Baton Rouge, La.	91 11	30 25	D. V. Guthrie	11½L, P26, Louisiana State Univ. Obsy.	
59	Baton Rouge, La.	91 11	30 25	K. M. Yoss	11½L, P26, Louisiana State Univ. Obsy.	
60	Baton Rouge, La.	91 11	30 25	L. A. Jeffries	11½L, P26, Louisiana State Univ. Obsy.	
61	Baton Rouge, La.	91 11	30 25	W. B. Payne	11½L, P26, Louisiana State Univ. Obsy.	
62	Columbia, Mo.	92 20	38 56	R. D. Levee	7½L, P16, Laws Obsy., Univ. of Mo.	
63	Columbia, Mo.	92 20	38 56	J. W. Reed	4¼L, 60x, Laws Obsy., Univ. of Mo.	
64	Columbia, Mo.	92 20	38 56	W. Beavers	2L, 70x, Laws Obsy., Univ. of Mo.	
65	Northfield, Minn.	93 09	44 28	Several	16L, P39, Goodsell Obsy.	
66	Albany, Minn.	94 34	45 38	R. M. Ohmann	8M, 136x	
67	Topeka, Kan.	95 42	39 02	Several	12L, 165x, Washburn Univ. Obsy.	
68	Crete, Neb.	96 58	40 37	L. C. Oleson	8L, 225x, Boswell Obsy., Doane Coll.	
69	Yankton, S. D.	97 23	42 53	Observer 1	7L, P24, Clark Obsy., Yankton Coll.	
70	Yankton, S. D.	97 23	42 53	Observer 2	7L, P24, Clark Obsy., Yankton Coll.	
71	Hesston, Kan.	97 25	38 09	L. Haines	8M, 124x, Hesston Coll.	
72	Austin, Tex.	97 44	30 16	Several	9½L, P10, Ast. Club, Univ. of Tex.	
73	Childress, Tex.	100 12	34 26	D. Davis, Jr.	6M, 63x	
74	Eagle Pass, Tex.	100 30	28 43	J. R. Smith	4½M, 160x, Skyview Obsy.	
75	Lewellen, Neb.	102 12	41 22	C. B. Stephenson	12M, P35	
76	Regina, Sask.	104 37	50 26	J. V. Hodges	4L, 150x, Regina Ast. Soc.	
77	Regina, Sask.	104 37	50 26	W. P. C. Kinsman	3L, P, Regina Ast. Soc.	
78	Denver, Colo.	104 57	39 41	Several	20L, P72, Chamberlin Obsy.	
79	Denver, Colo.	104 57	39 41	Several	12M, P24, Denver Ast. Soc.	
80	Truth or Conseq., N. M.	107 15	33 07	W. L. Minear	?	
81	San Diego, Calif.	117 04	32 47	E. Grudewicz	8M, P24, San Diego State Coll.	
82	San Diego, Calif.	117 04	32 47	C. Silvernail	8M, P24, San Diego State Coll.	
83	Elkins, W. Va.	79 52	38 56	M. J. Kelly	10M, 107x, Elkins College Obsy.	
84	Lansing, Mich.	84 26	42 43	A. Burmester	6M, P10, 84-90, Lansing Amateur Astronomers	
85	Lansing, Mich.	84 26	42 43	E. Carlson	6M, P10, 84-87, P25 at egress	
86	Lansing, Mich.	84 26	42 43	W. Clark	6M, P10	
87	Lansing, Mich.	84 26	42 43	C. Harris	6M, P10	
88	Lansing, Mich.	84 26	42 43	R. Elliott	8M, P10	
89	Lansing, Mich.	84 26	42 43	R. Schafley	8M, P10	
90	Lansing, Mich.	84 26	42 43	R. Stanish	8M, P10	
91	La Mesa, Calif.	117 ?	32 50	R. M. Lippert	2½L, 46x	

1. Nos. 83-91 were received late, and are not in order of longitude.
2. Nos. 1, 9, 10, and 19 are south latitude.
3. First figure, aperture to nearest quarter inch, in some cases stopped-down aperture; L, refractor, M, reflector; magnification, or diameter, P, of projected image in inches.

No.	Obs. time	Red'n.	Geoc. time	O − C	
	h m s	s	h m s	s	
44	40 24	+14	40 38	−03	
45	40 20	+24	40 44	+03	T
46	40 18	+24	40 42	+01	
48	15 40 16	+25	15 40 41	00	
49	40 24	+24	40 48	+07	
50	40 26	+26	40 52	+11	T
51	40 27	+25	40 52	+11	
53	40 42	+18	41 00	+19	T
56	40 20	+18	40 38	−03	
57	41 00	+23	41 23	+42	
59	40 32	+08	40 40	−01	T
60	40 28	+08	40 36	−05	T
61	40 26	+08	40 34	−07	T
62	15 40 24	+16	15 40 40	−01	t
63	40 17	+16	40 33	−08	t
64	40 16	+16	40 32	−09	t
65	40 14	+21	40 35	−06	T
66	40 11	+21	40 32	−09	u
68	40 34	+14	40 48	+07	
69	40 32	+16	40 48	+07	
70	40 31	+16	40 47	+06	
71	40 28	+11	40 39	−02	
72	40 42	+02	40 44	+03	T
73	15 40 40	+04	15 40 44	+03	
76	40 36	+19	40 55	+14	u
77	40 41	+19	41 00	+19	u
78	40 24	+06	40 30	−11	
79	40 35	+06	40 41	00	
80	40 50	−04	40 46	+05	T
81	41 05	−13	40 52	+11	
83	40 22	+28	40 50	+09	T
84	40 29	+27	40 56	+15	
85	40 16	+27	40 43	+02	
86	15 40 08	+27	15 40 35	−06	
87	40 18	+27	40 45	+04	
88	40 18	+27	40 45	+04	
89	40 18	+27	40 45	+04	
90	40 08	+27	40 35	−06	

CONTACT III

No.	Obs. time	Red'n.	Geoc. time	O − C	
	h m s	s	h m s	s	
1	18 06 44	+23	18 07 07	−04	
2	07 41	−36	07 05	−06	
3	09 01	−74	07 47	+36	u
9	06 30	−05	06 25	−46	
10	06 01	−05	05 56	−75	
11	07 12	−73	05 59	−72	T
12	08 13	−74	06 59	−12	
13	08 04	−72	06 52	−19	T
14	08 03	−73	06 50	−21	u
15	08 08	−77	06 51	−10	
16	18 08 10	−77	18 06 53	−08	
19	06 03	−10	05 53	−78	
20	07 36	−74	06 22	−49	
22	07 29	−71	06 18	−53	
24	07 56	−75	06 41	−30	
25	07 52	−77	06 35	−36	
26	08 20	−76	07 04	−07	
27	07 49	−76	06 33	−38	
29	08 08	−77	06 51	−20	
30	07 22	−76	06 06	−65	
31	18 07 36	−76	18 06 20	−51	
32	07 17	−76	06 01	−70	
33	07 30	−76	06 14	−57	
34	08 13	−77	06 56	−15	T
35	08 13	−77	06 56	−15	T
36	09 02	−70	07 52	+41	u
37	07 58	−70	06 48	−23	
38	07 59	−70	06 49	−22	
39	07 59	−70	06 49	−22	u
41	08 02	−75	06 47	−24	
42	18 08 02	−75	18 06 47	−24	
43	08 16	−76	07 00	−11	
44	08 01	−66	06 55	−16	
45	08 10	−74	06 56	−15	T
46	08 30	−78	07 12	+01	
48	08 06	−79	06 47	−24	
49	08 06	−79	06 47	−24	
50	08 14	−76	06 58	−13	T
51	07 55	−79	06 36	−35	
52	07 14	−78	05 56	−75	
53	18 07 25	−75	18 06 10	−61	T
54	07 55	−75	06 40	−31	T
55	08 14	−75	06 59	−12	T
56	08 39	−75	07 24	+13	u
57	08 00	−80	06 40	−31	
58	07 26	−67	06 19	−52	t
59	07 38	−67	06 31	−40	t
60	07 46	−67	06 39	−32	t
61	07 29	−67	06 22	−49	t
62	07 52	−76	06 36	−35	u
63	18 08 11	−76	18 06 55	−16	u
64	08 10	−76	06 54	−17	u
65	08 30	−80	07 10	−01	T
66	08 02	−81	06 41	−30	
67	08 10	−75	06 55	−16	
68	07 30	−78	06 12	−59	
69	08 00	−79	06 41	−30	
70	08 02	−79	06 43	−28	
71	07 20	−75	06 05	−66	
72	07 18	−68	06 10	−61	
73	18 07 10	−72	18 05 58	−73	
74	07 46	−66	06 40	−31	
75	08 12	−78	06 54	−17	T
76	08 06	−85	06 41	−30	
78	08 12	−77	06 55	−16	
79	07 27	−77	06 10	−61	
80	08 00	−71	06 49	−22	
83	07 38	−74	06 24	−47	T
84	08 01	−78	06 43	−28	
85	07 52	−78	06 34	−37	
86	18 07 52	−78	18 06 34	−37	
87	08 12	−78	06 54	−17	
88	08 03	−78	06 45	−26	
89	08 16	−78	06 58	−13	
90	08 04	−78	06 46	−25	

CONTACT IV

No.	Obs. time	Red'n.	Geoc. time	O − C	
	h m s	s	h m s	s	
1	18 09 50	+24	18 10 14	−34	
2	10 34	−37	09 57	−51	u
3	11 05	−71	09 54	−54	u
10	09 48	−04	09 44	−64	
11	11 10	−70	10 00	−48	
12	11 40	−70	10 30	−18	
13	11 38	−69	10 29	−19	
14	11 38	−69	10 29	−19	
20	10 43	−70	09 33	−75	
24	11 16	−72	10 04	−44	u
27	18 11 13	−73	18 10 00	−48	
28	11 12	−73	09 59	−49	
29	11 20	−73	10 07	−41	
30	11 10	−70	10 00	−48	
31	10 56	−70	09 46	−62	
32	11 12	−70	10 02	−46	
33	11 10	−70	10 00	−48	
34	11 44	−74	10 30	−18	
35	11 33	−74	10 19	−29	
36	11 15	−67	10 08	−40	u
37	18 11 21	−67	18 10 14	−34	
38	11 22	−67	10 15	−33	
39	11 26	−67	10 19	−29	u
40	11 45	−67	10 38	−10	
43	11 39	−73	10 26	−22	
46	12 01	−74	10 47	−01	
51	10 45	−76	09 29	−79	
52	11 24	−75	10 09	−39	
55	11 38	−72	10 24	−24	
57	11 12	−76	09 56	−52	
58	18 10 45	−64	18 09 41	−67	
59	10 46	−64	09 42	−66	
60	10 51	−64	09 47	−61	
61	10 37	−64	09 33	−75	
62	11 29	−73	10 16	−32	u
63	10 38	−73	09 25	−83	u
65	11 38	−76	10 22	−26	
66	11 37	−78	10 19	−29	
67	11 44	−72	10 32	−16	
71	11 10	−72	09 58	−50	
72	18 11 25	−65	18 10 20	−28	
73	10 12	−69	09 03	−105	u
76	11 41	−82	10 19	−29	
77	11 35	−82	10 13	−35	
78	11 42	−74	10 28	−20	
79	10 37	−74	09 23	−85	
80	11 28	−68	10 20	−28	
82	11 16	−53	10 23	−25	
83	11 12	−71	10 01	−47	

COMET PONS-BROOKS

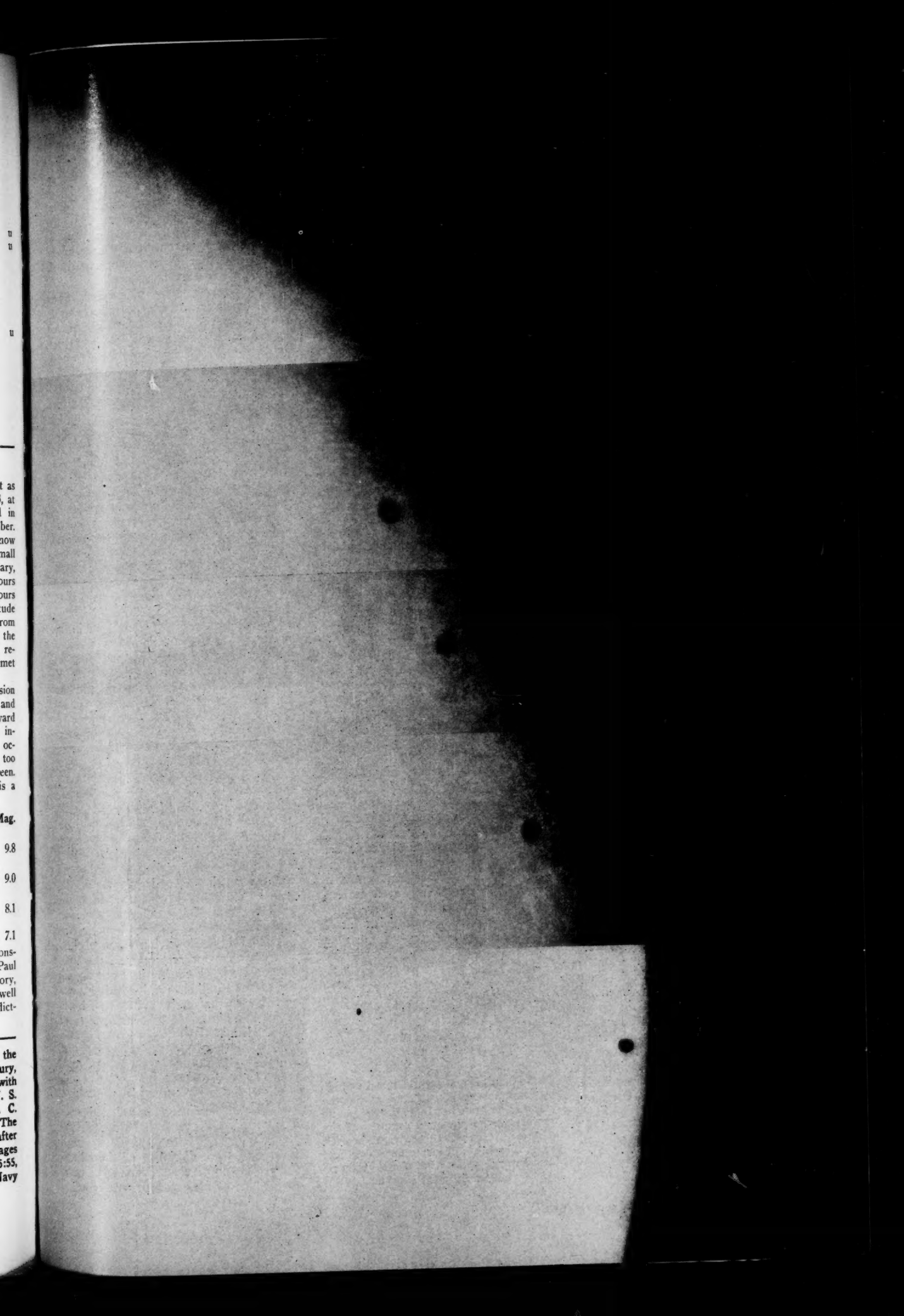
The recovery of this periodic comet as a 17th-magnitude object in June, 1953, at the Lick Observatory, was reported in **Sky and Telescope** for last September. Approaching the sun, the comet has now become bright enough to be seen in small telescopes. At the beginning of February, it will be in Cygnus, setting four hours after the sun, and rising about four hours before sunrise, for an observer in latitude 40° north. Its magnitude will change from about 10 to 9 during February. By the end of March, these intervals will be reduced to about two hours, and the comet will be about magnitude 7.

Thereafter, the comet's right ascension will remain nearly that of the sun, and it will begin to move rapidly southward toward the sun. For a considerable interval near perihelion passage, which occurs in late May, the comet will be too close to the sun in the sky to be seen. The 1954 apparition of this comet is a particularly unfavorable one.

1954 0h UT	R.A. (1950) h m	Dec. (1950) ° ′	Mag.
Jan. 28	20 29.7	+37 30	9.8
Feb. 7	21 01.1	+38 32	
17	21 36.4	+39 35	9.0
27	22 15.7	+40 30	
Mar. 9	22 59.3	+41 02	8.1
19	23 46.4	+40 54	
29	00 35.8	+39 49	7.1

The foregoing ephemeris of Comet Pons-Brooks has been supplied by Dr. Paul Herget, of the Cincinnati Observatory, who points out that the comet may well appear one magnitude fainter than predicted above.

FACING PICTURE: Five stages in the November 14, 1953, transit of Mercury, from photographs by J. L. Gossner with the 40-foot photoheliograph of the U. S. Naval Observatory, Washington, D. C. North is to the right, east above. The top image of Mercury shows it just after ingress, at 15:49 UT. Subsequent images indicate Mercury's position at 16:35, 16:55, 17:25, and 17:59 UT. From U. S. Navy photographs.



The Imperial Academy of Sciences at St. Petersburg as it looked in the days of Lomonosov. Its astronomical observatory was located in the central tower.

LOMONOSOV

By Otto Struve, *Leuschner Observatory*
University of California

WHO DISCOVERED the atmosphere of Venus? Was it the German astronomer, J. H. Schroeter, to whom, according to Rudolf Wolf's *Geschichte und Literatur der Astronomie,* belongs the credit of having shown in 1792 that the planet has an atmosphere? Or was it Sir William Herschel who, according to Agnes M. Clerke's *History of Astronomy During the Nineteenth Century,* had at about the same time "admitted that sunlight, by the same effect through which the heavenly bodies show visibly above our horizons while still geometrically below them, appeared to be bent round the shoulder of the globe of Venus"?

Or was it the Russian, Mikhail Vasilevich Lomonosov, who made his own claim in 1761—a claim which has been forcefully advanced by numerous present-day Soviet historians? On June 6, 1761, Lomonosov observed the transit of Venus across the disk of the sun. At his house in St. Petersburg he had installed a refracting telescope 4½ feet in focal length, with considerable chromatic aberration, but capable of giving good images near the center of the field. Although the principal purpose of his work was to determine the exact times of the contacts, Lomonosov "felt curious about the physical aspects of the phenomenon."

The results were described in an article, "The Appearance of Venus on the Sun as Observed at the St. Petersburg Academy of Sciences on May 26 [Julian calendar], 1761," which includes the observations of two assistants, A. D. Krassilnikov and N. G. Kourganov, who were stationed at the old observatory of the academy. This observatory was made famous by Joseph Delisle, who was for many years academician for astronomy in Russia, and was a friend of Lomonosov, who filled the chair of chemistry. For unknown reasons the article by Lomonosov was not published during his lifetime and it has remained unknown to most historians of science. It is not mentioned in Wolf's book (1877), or in R. A. Proctor's *Transits of Venus* (1874). It was printed in Volume V of Lomonosov's collected works, edited by M. I. Sukhomlinov in 1891-1902.

In St. Petersburg (now Leningrad) the transit started at 4 o'clock in the morning, with the sun low over the horizon. (In north latitude 60°, the end of May and June are the season of the "white nights" when the sky never becomes dark at night.) The end of the transit occurred at 10 o'clock in the morning, presumably under good conditions, because Lomonosov refers to the smoothness of the sun's edge.

The beginning of the transit came 40 minutes later than had been expected, despite the fact that Lomonosov had previously corrected the even more erroneous predictions of Halley, and of Epinus — another academician at St. Petersburg. The ingress of the planet was heralded by a slight "smudginess" of the edge of the sun; a similar haziness of the solar limb could also be discerned at the last contact. In a diagram like that shown here, Lomonosov drew attention to the "blister" on the edge of the sun, as Venus approached it before third contact, and explained in the following words: "The planet Venus is surrounded by a considerable atmosphere equal to, if not greater than, that which envelops our earthly sphere."

These diagrams, adapted from drawings by Lomonosov, show Venus leaving the sun at the transit of 1761. The circle represents the planet; a segment of the edge of the sun is to the right in each case. The blister became narrower, and disappeared when the planet was no longer fully on the sun.

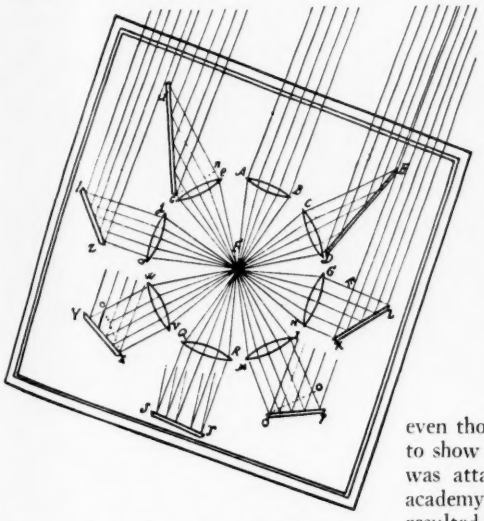
Lomonosov's great biographer, Boris N. Menshutkin, writes as follows about this passage: "Like almost all of his scientific discoveries, this too went unnoticed . . . and even now the discovery of the atmosphere of Venus is attributed to Schroeter and Herschel (1791)." (*Russia's Lomonosov,* Princeton University Press, 1952.)

Who, then, was this man Lomonosov? He was born in September, 1711, the son of a free peasant, on an island near the isthmus of the North Dvina River, not far from the city of Archangel. The father made his living as a well-to-do fisherman, and his son went on several fishing expeditions with his father into the White Sea, reaching at times a latitude of 70° north. At the age of 15, young Mikhail had learned to read and write and was beginning to show considerable interest in science. According to legend he ran away from home in the winter of 1730 and joined a train of sleds carrying frozen fish to Moscow. There he enrolled in a school attached to a large monastery, where, in addition to receiving the usual clerical instruction, he started reading books on mathematics, physics, and chemistry. He also was expected to learn to write simple verses, which developed in him a taste for poetry.

The Academy of Sciences of St. Petersburg had already been organized by the emperor Peter I and had been opened in 1725 by his successor on the throne, Catherine I. The members of the academy were all foreign scientists, among whom the mathematicians, L. Euler and D. Bernoulli, were already world famous. According to the statutes of the academy, one of its tasks was to select promising young students among the pupils of the various church schools and to train them for research and teaching. Lomonosov was chosen in 1735 among the 12 best candidates and was first transferred to the university at St. Petersburg, which functioned under the auspices of the academy.

A year later he was sent, together with several other students, to the German University of Marburg in order to study chemistry with Christian Wolf, and later to Freiburg to study mineralogy under I. F. Henkel. Although the young Russian students, suddenly freed from the severe discipline of the educational system in Russia, developed a taste for drink and caused much consternation

among the German professors through their dissolute behavior, Lomonosov made rapid strides in his studies and quickly learned the fundamentals of chemistry and physics, mineralogy and metallurgy.



In 1741 he returned to Russia, after having abandoned his wife, whom he had married at Marburg. He was appointed an associate member of the Academy of Sciences, upon the presentation of a learned paper on the construction of a solar furnace utilizing lenses and plane mirrors. The purpose of this device was to produce at the common focus of the lenses a spot of high temperature for the study of chemical reactions.

In 1745 Lomonosov was promoted to full membership in the academy, and during the following 20 years he held the chair of chemistry there. For part of this period he was director of the academy's chemical laboratory, which was built according to his plans.

However, Lomonosov did not confine himself to the study of chemistry. He was the first great scientist Russia had produced, and the scope of his work ran parallel to that of his contemporary, Benjamin Franklin, in the United States or the earlier Leonardo da Vinci in Italy. Among his astronomical publications the most important ones are concerned with navigation and practical astronomy. He developed a measuring device to determine the altitude of the sun at noon. With this and other similar instruments his assistants carried out numerous determinations of the co-ordinates of the principal cities of Russia, a task that enabled Lomonosov to construct the first accurate map of the Russian Empire. In order to determine the time, he independently invented a ship's chronometer driven by means of four springs which were to be wound at different times during the day.

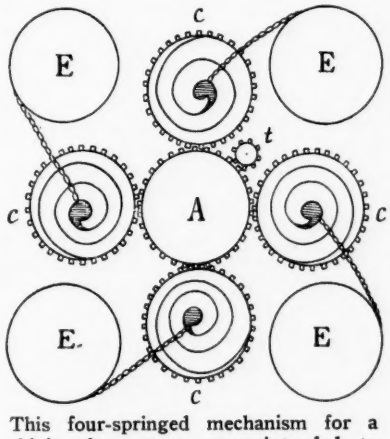
In optics, Lomonosov, independently of Herschel, invented a reflecting telescope with an inclined mirror, as shown here. Toward the end of his life, he strenuously defended his invention of a telescope intended for the observation of distant objects during the night. His contention that ships at sea or a shore line could be seen through his telescope, even though the contrast was insufficient to show such objects with the naked eye, was attacked by other members of the academy; their scientific gatherings often resulted in a dispute regarding the advantages and disadvantages of the proposed instrument. It is, of course, now known that even though the contrast is not increased by means of a telescope there is an advantage due to the magnification of the optical system.

Above: Lomonosov's sketch of a telescope with an inclined primary mirror and a plane secondary. It may be described as a transition between the Cassegrainian and Herschelian types.

Left: Eight lenses and seven plane mirrors concentrate the sun's rays in this solar furnace invented by Lomonosov in the year 1741.

Lomonosov spent much time in the study of electrical phenomena; he carried out at his home a series of experiments associated with lightning. As a result of these experiments, he suggested that such phenomena gave rise to the luminosity of comets, and that cometary tails might be similar in origin to the aurora borealis. He even advanced the hypothesis that the upper atmosphere of the earth might display luminous effects that are similar to those of comet tails and that the earth, as seen from another planet, might actually show a luminous tail in which electrical discharges take place.

Perhaps the greatest service which Lomonosov rendered astronomy was his defense of the Copernican system. This started almost as soon as he had returned to Russia in 1741 and involved him in a number of disputes with the leaders of the church. Not only did he fully accept the heliocentric system of Copernicus, but he was among those who maintained that the planets are in many respects similar to the earth, and even that life might possibly exist on them.



This four-springed mechanism for a ship's chronometer was intended to give a more uniform rate than a single spring would provide.

As a member of the academy, Lomonosov was expected to write occasional poems celebrating important events in the life of the country. He developed his own style, and among the people at large he is best known as the first of the great Russian poets. Among the best known of his poems, however, are those devoted to scientific subjects. In 1743, in a drunken spree, Lomonosov insulted several of his colleagues at the academy. Complaints were made against him, and on May 28th he was arrested and confined to jail for several months. During this period he wrote two of his most famous literary works, "The Morning and the Evening Meditations on the Divine Majesty."

It is almost impossible to reproduce in the English language the power and the rhythm of his verses. In 1822, Sir John Bowring translated both meditations in his *Specimens of the Russian Poets,* from which the following stanzas are of astronomical interest.

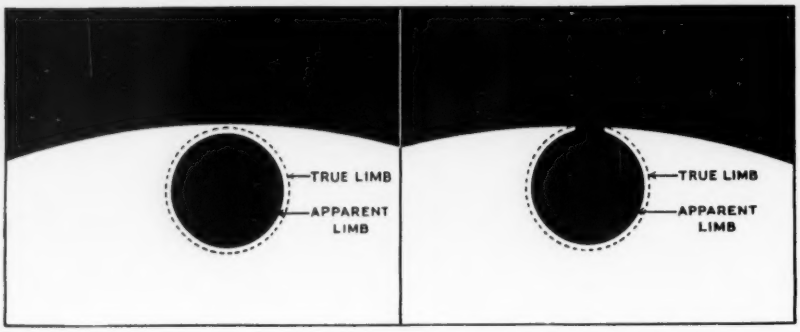
Oh, if a mortal's power could stretch so high—
If mortal sight could reach that glorious sun,
And look undazzled at its majesty,
'Twould seem a fiery ocean burning on
From time's first birth, whose ever-flaming ray
Could ne'er extinguish'd be by time's decay.

There waves of fire 'gainst waves of fire are dashing,
And know no bounds; there hurricanes of flame,
As if in everlasting combat flashing,
Roar with a fury which no time can tame:
There molten mountains boil like ocean-waves,
And rain in burning streams the welkin laves.

The day retires, the mists of night are spread
Slowly o'er nature, darkening as they rise:
The gloomy clouds are gathering round our head,
And twilight's latest glimmering gently dies:
The stars awake in heaven's abyss of blue:
Say, who can count them? Who can sound it? Who?

Even as a sand in the majestic sea,
A diamond-atom on a hill of snow,
A spark amidst a Hecla's majesty,
An unseen mote where maddened whirlwinds blow,
Am I midst scenes like these — the mighty thought
O'erwhelms me — I am nought, or less than nought.

There can be no question that Lomo-



The black drop effect, illustrated here for third contact, occurs while the narrow ring between the true and the apparent limbs of Venus is partly off the edge of the sun. The black drop may last for several seconds, making observations of contact times uncertain.

nosov's imagination led him to a realization of the incandescent nature of the sun long before astronomers were ready to regard these revolutionary views with favor.

The following poem illustrates his fight against the church in defense of the multiplicity of earthlike planets in the universe. His allusions to a beard reflect the fact that Peter I had ruled that only priests were permitted to wear long beards.

HYMN TO A BEARD

True it be that all the planets
Resemble ours as earthlike objects.
Be on one of them a long-hair
Priest, or self-appointed prophet:
"By my beard, I swear to you,"
He said, "the earth is through and through
A lifeless planet; all is bare."
One who remonstrated: "Man lives there."
At the stake they burned him
To punish this free-thinker's sin.

Let us now return to the problem of the atmosphere of Venus. After Kepler had computed the Rudolphine tables of the motions of the planets, he announced, in 1627, that Mercury and Venus would both pass over the disk of the sun in 1631 —the first on November 7th, the second on December 6th. He also predicted that Venus would again transit across the sun's image in 1761. The 1631 transit of Mercury was observed by Gassendi in Paris, but that of Venus was not seen despite the fact that Gassendi looked for it on December 6th and 7th. We now know that the transit occurred during the night at Paris.

In the meantime the Belgian astronomer Lansberg computed that another transit of Venus should take place in 1639. The beginning of this transit was observed, just before sunset on December 4th, by Jeremiah Horrocks, then the 20-year-old minister of the parish at Hoole, in Lancashire.

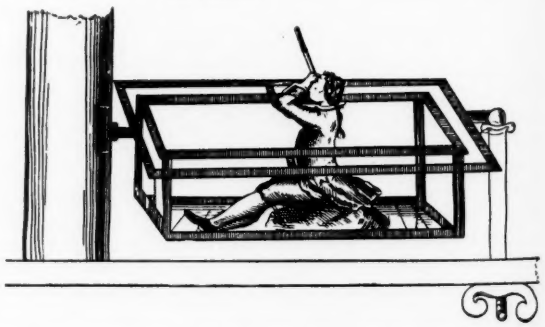
The importance of observing the transits of Venus in 1761 and 1769 was pointed out by Halley, who developed a method of determining the distance between the earth and the sun from accurate observations of the duration of a transit at two different places. However, most observers in 1761 noticed the effect of the black drop, which is illustrated here. It is due entirely to the apparent spreading of the bright disk of the sun on account of diffraction, imperfections of the telescope, and irradiation. What happens in effect is that the disk appears to extend beyond the real limb, and also protrudes into the geometrical black image of Venus. Therefore, Venus itself appears smaller than it really is. Only when the edge of the disk of Venus is so close to the edge of the sun that the hairline of sunlight between it and the edge of the sun is greatly reduced in brightness, will there be a short space along the limb of Venus in which this spreading effect does not occur. Instead, the eye sees something like an hourglass-shaped dark band extending from Venus out to the sky beyond. C. A. Young has pointed out that this effect can be easily observed "by putting the thumb and finger in contact, holding them up to a light within two or three inches of the eye and then spreading them: as they spread, a black filament will be seen between them."

Apparently Lomonosov did not observe this black drop although it was seen at the same transit by many others.

The question still remains whether the blister on the edge of the sun, seen by Lomonosov, actually represented sunlight passing through Venus' atmosphere that was either refracted in that atmosphere or underwent considerable scattering by small particles. The hypothesis of refraction has been recently discussed by the Russian astronomer, V. V. Sharonov. He accepts the observations as giving the true effect of the refracted light of the sun and computes from it the horizontal refraction in Venus' atmosphere. His result is four seconds of arc. This value seems to be much too small, partly because we know that the horizontal refraction of the atmosphere of the earth is about 35 minutes of arc. Sharonov himself concludes that the later transits of Venus in 1874 and 1882 yield a value of 20 seconds of arc.

This is perhaps compatible with the behavior of the atmosphere of the earth, since at high elevations the horizontal refraction does become much smaller and reaches values of the order of a fraction of one minute of arc. In reality, the density gradient in the atmosphere of Venus and the change of absorption with height above the planet's surface must give a value which is considerably smaller than the horizontal refraction at the surface. Nevertheless, it seems inescapable that the blister seen by Lomonosov cannot be reasonably accepted as a proof of the existence of an atmosphere.

Of course, it is now well known that when Venus is several degrees from the sun its atmosphere can be observed as a faint, narrow luminous ring around the planet. This faint luminosity was not observable in the telescopes of Lomonosov's day. However, when Venus is entering or leaving the sun at transit, the ring is more conspicuous. David Rittenhouse saw it at the 1769 transit which he observed from Norristown, Pa. But this phenomenon is not bright enough to account for Lomonosov's observation.



This cradle was proposed by Lomonosov to provide navigators with a stable observing platform on shipboard.

It is more difficult to dispose of his observations of the haziness at the edge of the sun when the planet was just outside the limb. Without knowing what the properties of his instrument really were, it is impossible to reach a definite conclusion. But Lomonosov's intuition has since been proven sound, that Venus has an atmosphere and is physically similar to the earth.

Much valuable information on Russia's first great scientist is contained in the memoir, *M. V. Lomonosov — Astronomer and Astrophysicist*, in Russian (Moscow, 1950), and I am indebted to its author, Dr. P. G. Kulikovsky, for several of the illustrations used here. — O. S.

What Maps of the Coming Eclipse Tell Us

By Paul W. Stevens, *Rochester Academy of Science*

THE TOTAL solar eclipse that will occur on June 30, 1954, has already been briefly described in the June, 1953, issue of **Sky and Telescope.** We shall now consider in more detail the information contained in the accompanying map, reproduced from the **American Ephemeris and Nautical Almanac.** Although the path of totality does not exceed 96 miles in width, the area of partial obscuration is very large, extending from Alaska to Ethiopia and from Yucatan to India.

On the lower part of the map is the boundary line of visibility, labeled "Southern Limit of Eclipse," along which there will be only a grazing contact of the limbs of sun and moon. There is no corresponding northern limit, because the area extends beyond the north pole, where there will be a partial eclipse of the midnight sun. It is the horizon that prevents the partial phase from being visible at more southerly latitudes on the far side of the pole. Where the middle of eclipse occurs with the midnight sun on the horizon, about 30 per cent of the solar diameter will be obscured.

There are other curves drawn on the map, each indicating the locus of points where the eclipse begins or ends at a certain time. In discussing these curves, it will be convenient to refer to the table of circumstances of the eclipse, reproduced here from the **American Ephemeris.**

The station where the table states that the eclipse begins is marked on the map by a dash labeled "First Contact" drawn across the "Eclipse begins at Sunrise" curve. This is the geographical location from which the moon's lower limb appears to meet the highest point of the rising sun, these two bodies having identical azimuths, and this is where the eclipse is first visible. The sunrise line on the earth's surface is tangent to the "Eclipse begins at Sunrise" curve at this station. At all other points along the curve, sunrise and the beginning of the eclipse occur simultaneously, but at times later than 10:00.9 UT. For those points farther north than that of first contact, the moon will be more southerly than the rising sun, and so the first notch in the solar disk will appear to the right of center.

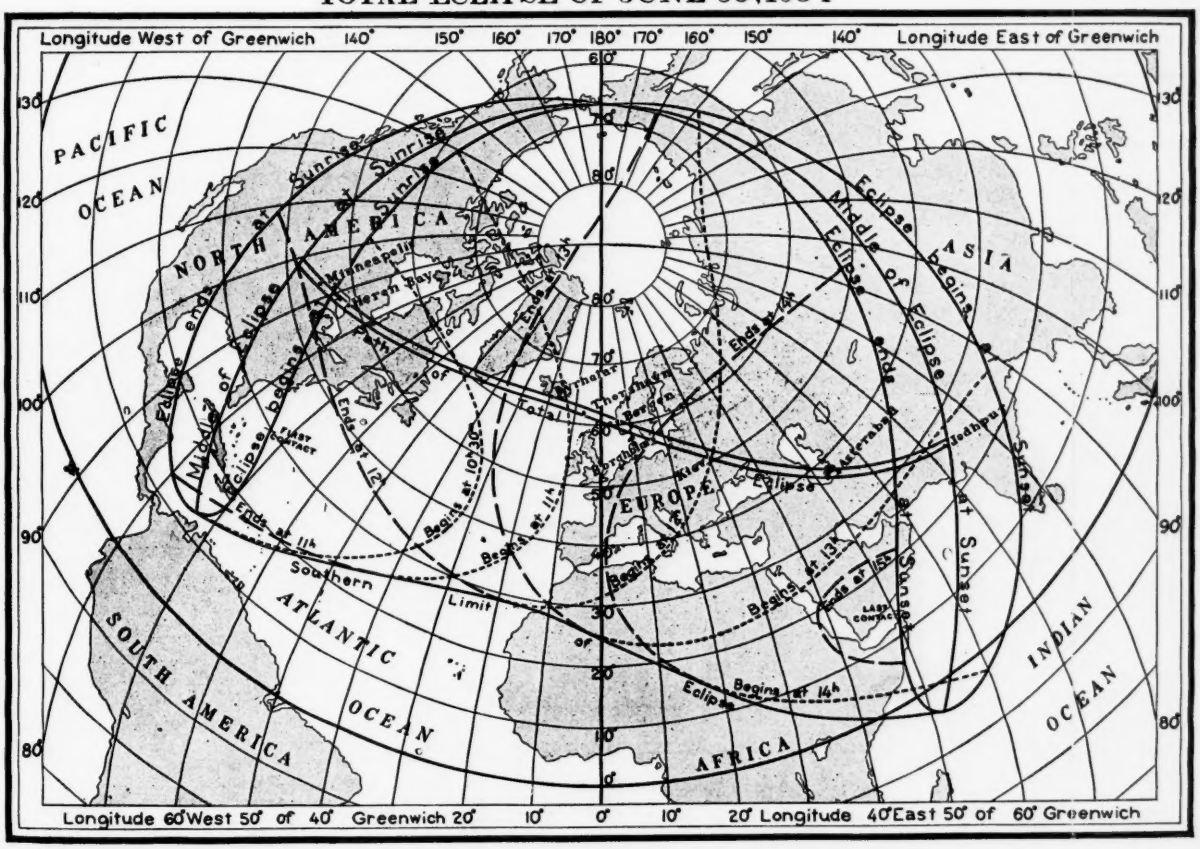
Notice that the position of first contact is considerably south of the "Path of Total Eclipse." This results from the oblique motion of the moon across the solar disk that is characteristic of eclipses near sunrise in the Northern Hemisphere. Later in the day, when the sun and moon have the same altitude, the moon will be north of the sun in azimuth, and the eclipse will be central at a more northerly latitude.

Inside a limited area west of the line where the eclipse begins at sunrise, the phenomenon will already be in progress when the sun appears. Along the curve labeled "Middle of Eclipse at Sunrise" the maximum obscuration of the sun will oc-

CIRCUMSTANCES OF THE ECLIPSE

	UT	Longitude	Latitude
Eclipse begins	10:00.9	+73° 34′	+29° 47′
Central eclipse begins	11:07.7	+99 04	+42 22
Central eclipse at local apparent noon	12:21.5	+ 4 32	+61 53
Central eclipse ends	13:56.6	−73 57	+26 19
Eclipse ends	15:03.4	−50 46	+13 11

TOTAL ECLIPSE OF JUNE 30, 1954



In this map, the lines of beginning join those of ending to outline the moon's penumbral shadow at the times shown. The maps accompanying this article are from the "American Ephemeris" and its supplement. Universal time is used.

cur when it is on the horizon. The western boundary of the area is marked "Eclipse ends at Sunrise." Here the eclipse would actually be invisible, were it not for the effect of dip of the horizon, because the point of contact of sun and moon is below the sun's upper limb, which is on the horizon for an observer at sea level. In the mountains of the western United States, the dip of the horizon will permit some observers considerably west of this line to view the eclipse.

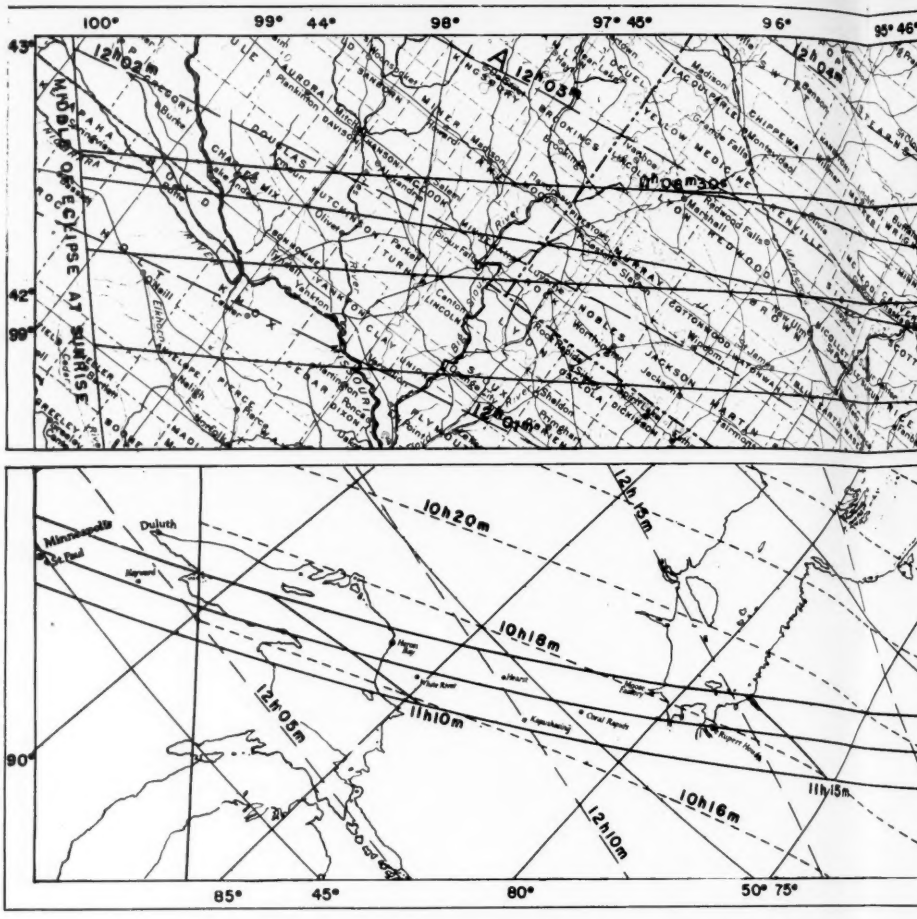
Similar considerations apply to the sunset curves at the eastern end of the region of visibility. In computing the positions of the curves where the eclipse begins or ends, the Nautical Almanac Office uses the times of actual sunrise and sunset. These are the instants when the upper limb of the sun, raised by atmospheric refraction, is tangent to the horizon. For mid-eclipse, however, the times of geometric sunrise or sunset are used; it is the center of the sun which is on the horizon, in the absence of refraction. Thus the solar altitude is 50 minutes of arc greater at geometric than at actual sunrise; this difference is the sum of the sun's radius, 16 minutes, and the mean refraction at the horizon, 34 minutes.

The loci of points where the eclipse begins at certain times are shown as fine broken lines that seem to expand outward from the position of first contact. Each of these lines is the intersection of the moon's penumbra with the earth's surface at the time stated. The coarse broken lines are the loci of the points where the eclipse ends at the indicated times. The final one of these, marked 15^h, is centered around the point of last contact.

The curves for beginning **and** ending at the same time merge into tangency with the "Southern Limit of Eclipse." At the point of tangency, there is a grazing contact at the time specified. This occurs, for example, at 12^h off the west coast of Africa.

If the centers of the sun, moon, and earth were in a straight line at the time of conjunction, the observer who could see the eclipse as total at that moment would have sun and moon in his zenith. The ends of the central line of totality would lie nearly on a diameter of the earth, provided the earth did not rotate. The range of longitude over which such an eclipse would be total would be exactly 180°, except for a small effect of lunar parallax. However, on June 30th the axis of the moon's shadow passes well north of the earth's center, and so crosses the meridians of longitude more rapidly. Offsetting this is the earth's rotation, which tends to decrease the rate

PATH OF TOTAL SOLAR ECLIPSE IN THE UNITED STATES, CANAD



The upper map shows the path of totality from Nebraska across South Dakota, Iowa, Minnesot

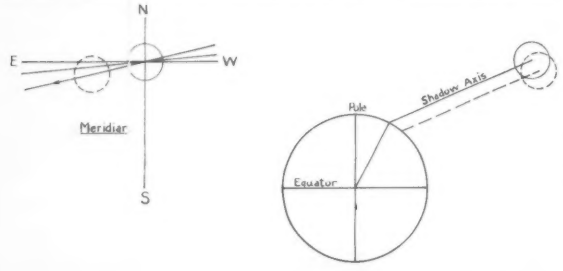
of progress of the shadow. The result in this case is that the extent of totality in longitude is 173° 01′.

The variation in latitude of the central line can be explained by the small diagram. On the right is the situation at 12:21.5 UT, when the eclipse is central at local apparent noon. While the earth and moon are shown to scale, the distance between them is not. The shadow axis and the observer's meridian lie in the plane of the paper. At the left is a sky view of the moon's position and path for the same time.

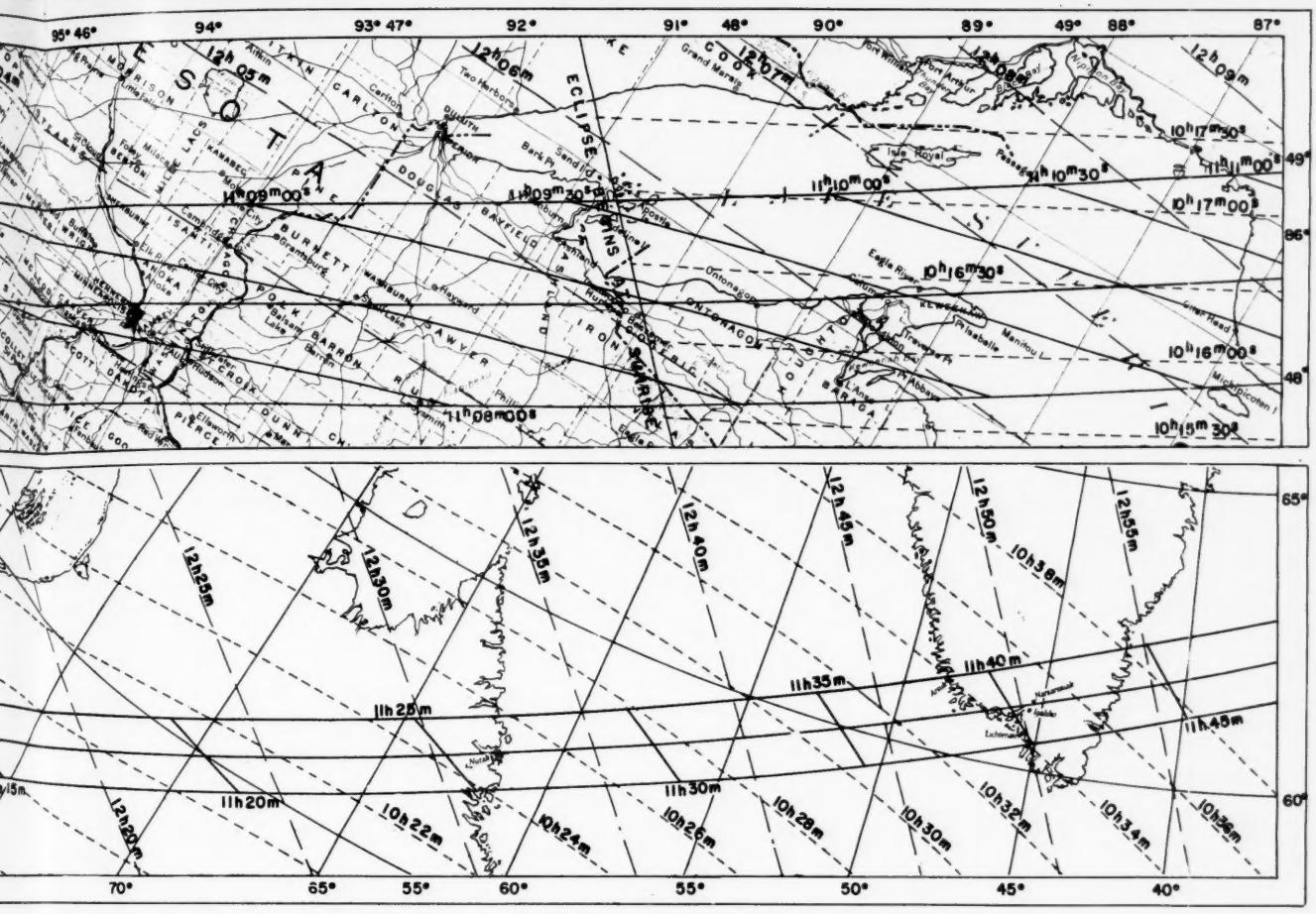
The arrow indicates the direction of the moon's motion against the celestial sphere. The other slanted line is the ecliptic; the angles that this and the moon's motion make with the east-west line are exaggerated for clarity. Note especially that the moon's motion in declination is southward. Looking back to the right-hand diagram, the dotted circle and line show the positions of the moon and the shadow axis at a later time. We see that totality now occurs at a more southerly latitude than when it took place at local noon.

When sun and moon are both on the meridian, the rotation of the earth retards the eastward component of the motion of the shadow axis, but has no effect on the southward component. The result is that the shadow axis is really moving toward the southeastern quarter; and this means that the maximum latitude of the central line is some 18° west of the point where totality is at local noon. Furthermore, the end of the path of totality is 16° 03′ farther south than its beginning. The reason that the central line advances northward and reverts southward is the northerly declination of the sun. However, this curvature of the central line is small because the moon's motion in declination is much less than average, for the eclipse takes place near the summer solstice.

To this general consideration of the visibility of the eclipse it is worth while to add a more detailed scrutiny of the path of totality across the United States,



Diagrams by the author to aid his explanation of the variation in latitude of the central line of the eclipse.



owa, Minnesota, Wisconsin, Michigan, and Ontario. The lower map continues the path eastward, on a smaller scale, as far as Greenland.

Canada, and Greenland. The basic source of this additional information is the booklet, **Total Eclipse of the Sun, June 30, 1954,** supplement to the 1954 **American Ephemeris.** Everyone seriously interested in the eclipse should own this pamphlet; it can be obtained from the Superintendent of Documents, Washington 25, D. C., for 40 cents.

Let us turn to the larger maps reproduced from the supplement. East of the line where the eclipse begins at sunrise, the entire phenomenon will take place with the sun above the horizon, while west of the line, the sun will rise partially eclipsed. This line, labeled on the upper map, is the nearly vertical line near the left edge of the lower map. Midway between the northern and southern limits of total eclipse is the central line, where the center of the moon appears to pass over the center of the sun and where the duration of totality is a maximum. At the limits, totality lasts but an instant.

The approximate time of the beginning of the eclipse, when the moon's disk first touches the sun's, can be found for any station near the path of totality with the aid of the lower section of the large chart (Map II of the supplement). The series of short-dashed lines, drawn for two-minute intervals, show when the eclipse begins. The solid lines across the path, drawn for five-minute intervals, give the times of mid-totality. Were these lines extended into the areas of partial eclipse on either side of the path, they would indicate the time of maximum obscuration of the sun, corresponding to the least separation of the centers of sun and moon. Finally, the long-dashed lines, also drawn for five-minute intervals, give the times of last contact when the eclipse is over.

Both the sets of broken lines actually represent instantaneous traces of the penumbra of the moon's shadow, and their directions are determined by the altitude and azimuth of the sun, and by the direction of the line joining the centers of sun and moon at the time of contact. (Analogously, when a star is occulted by the moon, the line would mark the points on the earth where immersion or emersion occurs simultaneously.) These lines are turned successively more clockwise, with respect to the central line of total eclipse, as time advances. At sunrise, they are parallel to the azimuth of the sun.

The earth's rotation affects the duration of the eclipse in two ways. First, the partial phase after totality lasts longer than the partial phase before totality, anywhere on these maps. Second, the duration of all phases of the eclipse increases with eastward advance in longitude. This is generally true wherever the sun is east of the meridian at mid-eclipse. As the sun becomes higher in the sky, the component of velocity of the earth's surface at right angles to the axis of the moon's shadow increases. The result is that the relative speed of the shadow across the earth diminishes, and the eclipse lasts longer.

At the top of the large chart (Map I of the supplement), the path of totality in the United States is shown in still further detail. Here the times of first contact and mid-eclipse are indicated at 30-second intervals while those of last contact are for every minute. Latitude and longitude are marked at each degree.

A final item is that the locus where mid-eclipse occurs at sunrise is not at right angles to the central line but is rotated slightly counterclockwise from the perpendicular. This is because totality at the northern limit of the path takes place nearly a minute after it occurs at the southern limit. The instantaneous sunrise line is always perpendicular to the sun's azimuth, and hence to the central line at its initial point in Nebraska, and advances slightly westward during the seconds that mid-eclipse at the horizon moves from the southern to the northern limit of totality.

Amateur Astronomers

Planetarium Work with Deaf Children

DURING the past year, installation of a Spitz planetarium at the Newark Museum stimulated a great deal of interest and curiosity among the children of the city. Deaf boys and girls who attended the Bruce Street school in Newark were no exception; however, they could neither hear a lecture nor speech-read lips in the darkened chamber. Their teachers and the museum staff members were perplexed to know how a planetarium performance might be made meaningful for them.

It was proposed that slides containing the gist of the lecture in written form might be flashed on the dome. This basic idea proved feasible, and 44 deaf children, ranging in age from eight to 16, and 14 adults including parents and educators, attended a special planetarium performance.

The language of the lecture was considerably simplified. Each slide included a single concept, expressed so the children could understand and read it with comparative ease and rapidity. The slides were typed on Radio Mats, and bound with etched glass for both covers to reduce the amount of light projected. The slide projector was encased in a box, further eliminating extraneous light, and mounted at a 45-degree angle to project against the eastern section of the dome.

The instructor flashed each slide over the star images, then indicated on the dome with his red arrow the particular star, constellation, or phenomenon discussed, before turning off the slide projector. Twenty-nine slides were shown in 45 minutes, which is about the time of a regular performance.

All of the concepts included in this lecture had been previously presented to the children. For weeks teachers at the Bruce Street school used the coming planetarium visit as a major interest around which speech, speech-reading, language, and reading lessons were built.

In the planetarium the only totally new experiences for the children were the form of the reading material on the slides and the actual demonstration of the heavens. Interest was at a high pitch, made apparent by the periodic delighted gigglings and squirmings, ample proof to the adults present that the children really understood and were enraptured.

As far as we know, this planetarium performance was the first one ever made comprehensible to deaf children. The venture was certainly worth while, and we hope to repeat it again this year.

Walter Petersen
Newark Museum
Newark 1, N. J.

After marking the inside surface of a black umbrella with chalk, Miss Frances Phillips, of the Bruce Street School for the Deaf in Newark, N. J., demonstrates the apparent circular movement of polar stars to her pupils. Later they attended the special planetarium performance. Photo by Almon W. Johnston.

RICE PLANETARIUM

One of the few planetariums in the country to be owned and operated by an individual opened recently in St. Petersburg, Fla. The planetarium is named for Dr. Laban Lacy Rice, former chancellor and president of Cumberland University, who is its director.

The instrument, a Spitz projector, is housed in an auditorium 24 feet square, seating 80 persons. The 12-sided dome is suspended from a ceiling 18 feet high and extends to within six feet three inches of the floor level. A small astronomical museum is in the anteroom. Demonstrations are scheduled for 10:30, 2:30, and 8 o'clock weekdays, and 2:30 on Sunday. The building is at 4700 Lakeview Ave.

PROGRESS IN MEMPHIS

The Memphis Astronomical Society (reported on in the August, 1953, issue), organized for about a year, now has 17 members. We have just become affiliated with the local museum, where we present public lectures on the first Friday of each month, and where we have an astronomical display. We are now the proud possessors of a 12-inch, motor-driven reflector. Mirror grinding projects continue. Recently, after attending several conventions, we decided to join the Astronomical League.

Jon M. Buhler
3976 Central Ave.
Memphis, Tenn.

THIS MONTH'S MEETINGS

Buffalo, N. Y.: Buffalo Astronomical Association, 7:30 p.m., Museum of Science. Feb. 3, Dr. Davis, University of Buffalo, "Astronomical Mechanics."

Columbus, Ohio: Columbus Astronomical Society, 8:00 p.m., Chemistry Bldg., Ohio State University. Feb. 13, Phillip Stanger, Perkins Observatory, "The Theory of Relativity." The public is invited.

Dallas, Tex.: Texas Astronomical Society, 8 p.m., SMU Science Bldg. Feb. 22, Dr. J. W. Harrington, Southern Methodist University, "Weighing the Earth and Estimating Its Internal Character."

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. Feb. 9, A. V. Carpenter, to be announced.

Lansing, Mich.: Lansing Amateur Astronomers, 8 p.m., No. 8 Fire Station. Feb. 18, Birt Darling, "Variable Stars."

Lorain, Ohio: Black River Astronomical Society, 8 p.m., Spang Bldg. Feb. 3, symposium, W. A. Mason, leader, "The Astronomer's Tools."

Minneapolis, Minn.: Minneapolis Astronomy Club, 7:30 p.m., Public Library. Feb. 3, Cleon Cain, "Variable Stars."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Feb. 3, U. Sherman Lyons, U. S. Naval Observatory, "Astronomy and the Tides."

Teaneck, N. J.: Bergen County Astronomical Society, 8:30 p.m., Observatory, 107 Cranford Pl. Feb. 10, Capt. C. V. Lee, "Visits to the Observatories of the West."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. Feb. 6, Dr. Leason H. Adams, past director, Geophysical Laboratory, Carnegie Institution of Washington, "The Origin and Internal Constitution of the Earth."

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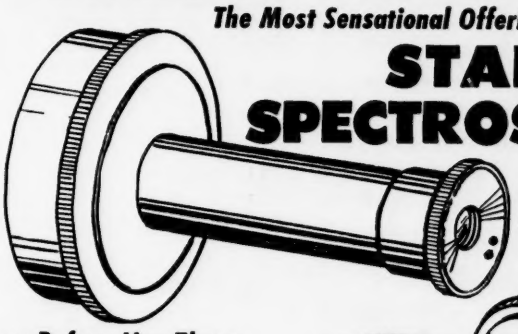

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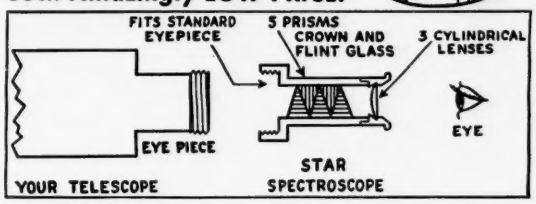

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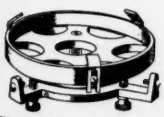

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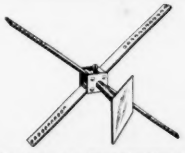

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BOOKS AND THE SKY

A HISTORY OF ASTRONOMY FROM THALES TO KEPLER

J. L. E. Dreyer. Dover Publications, Inc., New York, 1953. 438 pages. $3.95 cloth, $1.95 paper.

DREYER'S **History of the Planetary Systems from Thales to Kepler** (1905) is now available in a photo-offset edition. Thanks to the well-established principle that no author has the right to choose the title of his book, a new title page will help to produce many misleading references, though at least the page numbering has remained unchanged. The editor has written a short introduction which places the book in the proper perspective, and has added a useful bibliography.

Dreyer's work is undoubtedly one of the best existing introductions to the history of astronomy. It is written with an excellent sense of proportion by a competent astronomer who worked extensively with source material, for example, as editor of Tycho Brahe's collected works. But the lapse of 50 years is a long time for a summary of present knowledge, and Dreyer's book is not exempt from the process of aging. It would be unfair to review it now as if it were written today. The following remarks are only intended to warn a reader not to take for granted what could hardly have been said better half a century ago.

The weakest part of the whole work is obviously, as the editor remarks, the chapter on early Greek astronomy. Though Kugler's **Babylonische Mondrechnung** was published in 1900, nobody took serious notice of it except, of course, Father Cumont, who through his work on the relations between the Near East and the Roman-Hellenistic world, was eminently prepared for the proper evaluation of the new discoveries. Indeed he, himself, published important Greek parallels in his monumental work, the **Catalogus Codicum Astrologorum Graecorum.** But such heretical literature was at that time (and even now) off bounds to most classical scholars, and so the "Babylonians and Egyptians" remain the convenient neutral source, defying analysis, to which one may refer whenever a **deus ex machina** is required.

Of course, when concrete astronomical questions were involved, Dreyer could not be misled by the traditional fairy tales. Thus, he raised serious doubts about the possibility of Thales having predicted a solar eclipse. Though such doubts have been repeatedly voiced by astronomers, and though the textual situation itself is very suspicious, one can be sure that the story will remain a cornerstone of histories of astronomy.

It is also well known that the "Griechische Mensch" is either a philosopher or a geometer, but has no mind for such low occupations as numerical computation. Consequently, the histories of ancient astronomy (excepting always Delambre's truly remarkable work) uniformly ignored the numerical and graphical methods that we know from Ptolemy and others, and badly neglected the numerical tables of Ptolemy and Theon, although they form a most significant part of the ancient heritage to the Islamic world. Here again Dreyer is a victim of the general tendency of focusing all attention on cosmogonic speculations while astronomical tables remain unpublished. Al-Battani's tables were only edited by Nallino and Schiaparelli in 1907, and al-Khwarizmi's tables in 1914. And here we still stand today.

A careful search through Suter's work on the Islamic literature in mathematics and astronomy, published in 1900, could have prevented Dreyer from making such completely wrong statements as the one to the effect that Ulugh Beg's catalogue of stars in the early 15th century was the first since Ptolemy. But the fact remains that no correct appreciation of astronomical work during the Middle Ages is possible before the enormous masses of relevant texts are made available. If possible, even worse is the situation for Hindu astronomy, which played such an important role for the transmission of Hellenistic astronomy to the Islamic world as well as to the Far East, which then, in turn, influenced the West during the Mongol dynasties.

The new edition of Dreyer's book brings the work again to the reach of those who try to inform themselves and others about the main trends in the development of astronomy. They will find it interesting and competent alike. They will do well, however, if they never trust any general survey, be it written now or a hundred years ago, but turn to the sources themselves. Dreyer's careful notes make it easy for a serious reader to form an opinion of his own.

O. NEUGEBAUER
Brown University

THE RED AND GREEN PLANET

Hubertus Strughold. University of New Mexico Press, Albuquerque, 1953. 107 pages. $4.00.

THE PANIC resulting from Orson Welles' famous broadcast should be sufficient proof that the possibility of life on Mars is taken seriously by a considerable fraction of the American public. Huygens, Fontenelle, and Kant took for granted that the other planets of the solar system were, like the earth, inhabited by reasonable creatures. Nearer our time, Percival Lowell devoted years of his life to "proving" that intelligent beings must exist on Mars. **The Red and Green Planet** now brings the views of a physiologist on the possibility of life on Mars.

The author is the director of the department of space medicine in the Air Force School of Aviation Medicine. Before coming to America in 1947, he had been director of the Aeromedical Research Institute in Berlin, and after the war, professor of physiology at Heidelberg. In 1939 he was one of the two joint authors of the standard German textbook on aviation medicine. He is therefore a biologist, and it is from the viewpoint of ecology that he examines the problem.

This in itself is a novelty as the subject has been so far debated mostly by astronomers and physicists: Camille Flammarion, Svante Arrhenius, Lowell, W. H. Pickering, G. P. Kuiper, Harold Spencer Jones, and G. de Vaucouleurs, among others.

As a biologist, Professor Strughold lists the main characteristics of a physiological environment: availability of the elementary constituents of living matter, temperature, illumination, water, and partial pressure of oxygen. The availability of carbon, hydrogen, oxygen, nitrogen, and of some associated elements, phosphorus, sulphur, magnesium, iron, and others, is a prerequisite of the existence of life as we know it. That **as elements** they exist on Mars he considers established from studies of the Martian atmosphere and polar caps, and from general knowledge concerning other planets. The existence of polar caps of ice or frost also demonstrates the presence of water on Mars. He regards temperature as the most decisive factor in establishing a suitable environment for life. He shows that the temperature range on Mars, which is from about 95° F. below zero to 85° above, coincides with the lower half of the earth's biothermal band. The Martian temperature range goes little below the earth's range (a temperature of 90° below zero was recorded in 1892 at Verkhoyansk, Siberia). However, ability of many organisms to survive, under conditions of latent life, at extremely low temperatures (liquid helium in the case of certain spores) suggests that this range is more than adequate for the maintenance of life.

On the other hand, the matter of oxygen partial pressure raises a much more difficult problem. The main constituents of the Martian atmosphere would appear to be nitrogen, argon, and carbon dioxide. Oxygen, if present at all, exists in minute traces, representing a pressure less than one millimeter of mercury. As human beings cannot survive in an atmosphere with an oxygen pressure less than 80 millimeters, Professor Strughold concludes that the presence on Mars of creatures resembling men belongs to the realm of fantasy. Other warm-blooded animals are excluded for the same reason. Cold-blooded animals, although they can survive in atmospheres extremely low in oxygen, do so under conditions of latent life which would preclude growth, activity, and reproduction. Higher plants and microorganisms are similarly dependent on the availability of oxygen.

These considerations leave, as the only possibility, lower orders of plant life such as lichens and mosses. It has been suggested lately by Kuiper that the infrared spectrum of the green areas of Mars is compatible with that of lower vegetable orders. Martian surface illumination and temperature are sufficient for photosynthesis. Carbon dioxide is present, probably in greater amounts than in the atmosphere of the earth. Strughold considers that it is possible that "specially constructed" lichens and liverworts might release the oxygen produced during photosynthesis reactions, not externally, but internally into intercellular air spaces or air chambers like those in the thallus of terrestrial lichens and liverworts but perhaps more leakproof. This hidden store of oxygen would be available for respiratory processes during daytime. At night, with the cessation of photosynthesis, a rapid oxygen depletion would take place and the plant would "noctivate."

The next to last chapter compares the atmospheres of Earth and Mars. Having resigned ourselves to the absence of any form of higher life on Mars, we are somewhat cheered by Professor Strughold's statement, "yet with a few mechanical aids — of a sort that we now supply to pilots soaring into the upper levels of the atmosphere — a man should be able to maintain himself on Mars for a considerable time without discomfort." While the low oxygen pressure makes useful fire impossible (thus excluding matches, automobiles, airplanes, "cigarette lighters, gas stoves or a good five-cent cigar"), this has the beneficial result that "no racing prairie fires will ever sweep across the parched vegetation, destroying the plants that have struggled so hard for life in that arid land."

The last chapter is a strong plea for the construction of "Mars chambers" or for "a research laboratory, here on earth, in which conditions as they are found on other planets could be reproduced as a setting for biological experiments." Strughold readily concedes, however, that the real test of his hypotheses can only come from a visit to Mars, an undertaking for which "we await only the money and

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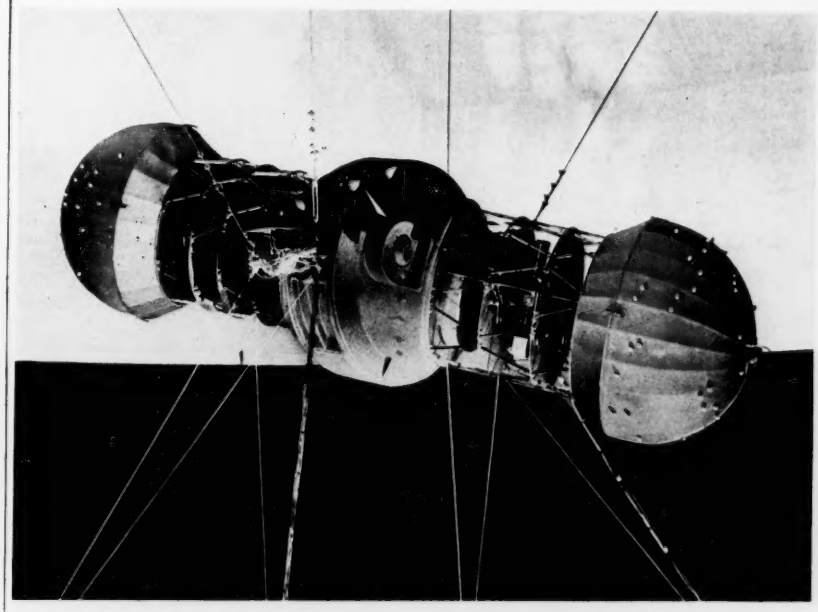

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the concerted effort. . . . When that day comes, no one will be more agreeably surprised than myself to find — or, better, to hear — that the conclusions reached in this book are utterly wrong."

In the opinion of this reviewer, himself a physiologist, the conclusions are entirely reasonable if the data on which they are founded are sound. A study of the possibility of life on Mars based first of all on known ecological facts is a welcome addition to the growing "space" literature. The desirability of this study being published as a book, however, can be questioned. The relative paucity of available information would suggest that an article in one of the more serious popular magazines would have covered the ground as well as does a four-dollar book. The price, incidentally, appears somewhat inflated for a thin volume.

There are a number of errors and inconsistencies. Photosynthesis is described as a transformation of "kinetic energy (sunlight)" into food energy (page 16), and the terms heat and temperature are used interchangeably (page 83). There are some apparent contradictions. We are told on page 63 that on Mars "water may occur . . . mainly in the form of snow and vapor. This factor of water is perhaps the weakest one in the planet's combination of conditions for photosynthesis." By contrast we read on page 86 that, considering the air pressure and the temperature on Mars, "water will remain in a liquid state and not dissolve in vapor." Mishaps of this type could doubtless have been avoided in such a short volume. The index is useful, and although the bibliography contains a number of misspellings, it covers the subject adequately.

The book answers many of the questions that everybody, at one time or another, has raised concerning life on Mars. It is also a useful addition to the library of parents of space cadets — an immense group in modern Western society — and may serve as a tool to inculcate into receptive young ears some of the principles of general ecology.

JEAN MAYER
Harvard School of Public Health

THE ELEMENTS OF ASTRONOMY FOR SURVEYORS

R. W. Chapman and J. B. Mackie. Charles Griffin and Co., Ltd., 42 Drury Lane, London W.C. 2, England, 5th edition, 1953. 245 pages. 26s.

A TEXTBOOK should have three dimensions: structure, content, and style. Measured in this way, this volume is an entirely satisfactory piece of craftsmanship.

This is the fifth edition of a work which first appeared in 1918. The original intention of the author was to create "...an elementary work suitable for the student and for the surveyor who is taking up astronomical observation for the first time." The text has been kept completely up to date by additions and revisions.

Often, the structure of a textbook is dictated by the subject matter. This is particularly true of practical astronomy, and the author has followed a fairly well-established pattern in the arrangement of his material. Yet the transitions are smooth and effortless, so that the student is not aware of any abrupt switch from one subject to the next.

While this volume is directed toward surveyors, it is not obviously so, with the result that a very few changes could make it an excellent first text on practical astronomy in general. Indeed, the reader often forgets the limited purpose of the book, and is brought up sharply by a statement or an omission. For example, after discussing geographic and geocentric latitude, the text turns to other subjects; we are a bit shocked by the omission of astronomical latitude, and look in vain for a footnote. But astronomical latitude is caviar to the surveyor, and the author has not acted unwisely in neglecting it.

On the other hand, there are omissions this reviewer believes are serious. Fortunately these are few. The most important is in relation to lines of position. The author — or the reviser — does not speak of plotting lines of position on a Mercator chart, or a scaled plotting sheet. Of necessity, therefore, the student is required to resort to computation to interpret a fix so obtained. This is a serious drawback, because computing a fix with more than two lines of position is tedious, whereas a fix may be easily obtained by plotting even if three, four, or more lines of positions are used.

There are one or two other small faults. The notation is fairly consistent, but there are minor deviations here and there. Also, the author sometimes neglects to describe the circumstances under which a particular

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type of observation may be desirabie or even necessary. The reader is thus unable to appraise the value of various types of solutions.

All in all, **Elements of Astronomy for Surveyors** is a valuable work and one which this reviewer will keep on his shelf between Chauvenet and Bowditch. But this question must be asked: While this is an excellent book for the student, and eminently suited for classroom work, how well does it fill the needs of the "surveyor who is taking up astronomical observation for the first time"? Personally, we doubt whether the practicing surveyor, who has been out of the schoolroom for any number of years, would be able to master this volume without a little help.

SIDNEY I. SCHEUER
Amateur Astronomers Association
New York City

FUN WITH ASTRONOMY

Mae and Ira Freeman. Random House, New York, 1953. 58 pages. $1.50.

A 10-YEAR-OLD child faces the bright world of nature with a fresh curiosity that, if unsatisfied, can subside into the dull unawareness of the average adult, whose horizon is limited to man and man's productions. At this time the child views with eager wonder birds, animals, and plants, and the moon and stars. How can his interests be fed and made self-perpetuating? Usually not by an adult enthusiast, who seldom can bring himself to the child's own level, and seldom appreciates the child's desire to do things himself. Thus there is a very great need for simply and carefully written books for young children on natural science. Mr. and Mrs. Freeman's **Fun with Astronomy** is a book of this kind.

It contains short, clearly written and well-illustrated sections, nearly all of which involve some naked-eye observation or simple experiment. Thus the child is told how he can see the rotation of the earth for himself, by watching for a few minutes the drift of southern stars past an upright post. The phases of the moon are explained with a rubber ball; how to find the size of the sun with a pinhole camera is described; and there are some simple star charts for finding the more conspicuous constellations. All this is told so simply that an eight-year-old can follow most of it; and, most happily, the presentation is quite free from any coyness, so that it is also appropriate for considerably older boys and girls.

The factual information in the book is accurate and the numerous illustrations are well chosen. Only one error was noticed: On page 32 we read, "Saturn is found in the southeastern sky in spring and in the southwest in summer," and there is a corresponding statement about Jupiter, without any indication that this is not always true. This could be badly misleading to the child trying to recognize these planets a few years hence. But this is an isolated slip. **Fun with Astronomy** can be warmly recommended to any parent, relative, or friend of an eager child.

MARTHA D. ASHBROOK
Weston, Mass.

NEW BOOKS RECEIVED

NUCLEAR PHYSICS, *W. Heisenberg*, 1953, *Philosophical Library*. 225 pages. $4.75.

In his preface Heisenberg states, "This book was based originally on a series of lectures, and is intended for readers who, while interested in natural sciences, have no previous training in theoretical physics and yet are familiar to a certain extent with physical ideas." The present edition appears to be a translation of the German revision of 1948 without substantial change.

FLIGHT INTO SPACE, *Jonathan Norton Leonard*, 1953, *Random House*. 307 pages. $3.50

General readers will find here a popular but comprehensive account of the problems of interplanetary travel. Considerable space is devoted to the present state of rocketry and to astronomical background. The author is the science editor of *Time*.

AMATEUR TELESCOPE MAKING, BOOK THREE, edited by *Albert G. Ingalls*, 1953, *Scientific American*. 644 pages. $7.00, foreign $7.35.

More than 40 contributions by both professionals and amateurs describe aspects of telescope making as diverse as figuring a Schmidt correcting plate and choosing the best paint for a dome. Like its predecessors, *Amateur Telescope Making* and *Amateur Telescope Making Advanced*, this new compilation of information on practical optics will be a standard reference work.

THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC FOR THE YEAR 1955, *Nautical Almanac Office*, U. S. Naval Observatory, 1952, *U. S. Government Printing Office*, Washington, D. C. 640 pages. $3.75.

The 1955 volume of the *American Ephemeris* is identical in plan with that for 1954. As in previous years, there are precise ephemerides for the sun, moon, the planets from Mercury through Pluto, and the first four asteroids; full predictions are given on eclipses, occultations, and satellites; and there is a wealth of further material useful to the observer and the computer.

MEASUREMENTS OF DOUBLE STARS, *G. Van Biesbroeck*, 1954, *University of Chicago Press*. 223 pages. $10.00.

This work lists measurements of the position angles and separations of about 2,500 close double stars, mostly in the years 1935 to 1951, with the 40-inch Yerkes refractor and the 82-inch McDonald reflector. New orbits are given for 19 binary systems, and new dynamical parallaxes are published for many slow-moving pairs. The book is Volume VIII, Part VI, of the *Publications* of the Yerkes Observatory.

A BIBLIOGRAPHY ON METEORITES, edited by *Harrison Brown*, 1953, *University of Chicago Press*. 686 pages. $10.00.

Over 8,600 major references to the literature of meteorites from 1491 to 1950 are collected here from over 1,000 journals and more than 800 books and pamphlets. The references are arranged chronologically, and are followed by an author index and a list of periodicals consulted. This compilation precedes two contemplated volumes "which will outline in some detail our present knowledge concerning meteorites and their properties."

GENERAL CATALOGUE OF STELLAR RADIAL VELOCITIES, *Ralph E. Wilson*, 1953, *Carnegie Institution of Washington*. 344 pages. $2.50 paper, $2.85 cloth.

Astronomers working in stellar motions and galactic structure have found an indispensable tool in J. H. Moore's catalogue of the radial velocities of 6,739 stars, published in 1932. The need for a revision of his list has been met by Ralph E. Wilson's new catalogue of 15,106 stars, clusters, and galactic nebulae, which is Vol. VIII of the *Papers* of the Mount Wilson Observatory. For each entry there is given the 1950 position, magnitude, proper motion, spectral type, radial velocity averaged from different sources, and notes. An appendix lists the velocities obtained at different observatories for those stars on the observing lists of more than one institution.

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EDITED BY EARLE B. BROWN

Making a Double-ring Spider and Elliptical Diagonal

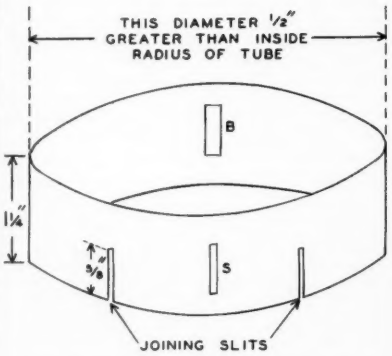
IN RECENT YEARS much has been written about the advantages of a circular support for the secondary mirror of Newtonian telescopes. There is no doubt that with some form of circular support the diffraction effects that appear with the usual four-legged or three-legged spider diminish or become less noticeable. With circular supports, such bright stars as Vega, Spica, and Arcturus appear as brilliant spots of light in a deep, black field.

The modified system of two interlocking rings described here has been used in practically all the reflecting telescopes constructed in the Buhl Planetarium by the Amateur Astronomers Association of Pittsburgh, and their owners are delighted with the actual observing results.

The following materials are required: 1. A piece of cardboard larger than the cross-section of the telescope tube. 2. Two brass rings 1¼" wide and with a diameter ½" greater than half the inside diameter of the main tube; this brass should be 18 gauge or thinner. 3. One piece of round solid brass stock, 1" in diameter and 1¼" long. 4. One piece of ¼" round brass rod, 20-threaded, 4" to 6" long. 5. Four 4-40 machine screws, ¼" long. 6. Two ¼-20 standard bolts and nuts, long enough to take the wall thickness of the main tube plus the thickness of a brass ring and a washer. 7. Two ¼-20 standard nuts, to fit the ¼" threaded rod.

Place the main tube upon the cardboard and scribe the outside diameter circle. Then remove the tube and determine the wall thickness in order to inscribe another circle with the inside diameter of the tube. Using the method of perpendicular bisectors, lay out two straight lines at right angles to one another precisely through the center of the circles. This will be the checking point for further operations until the system is complete.

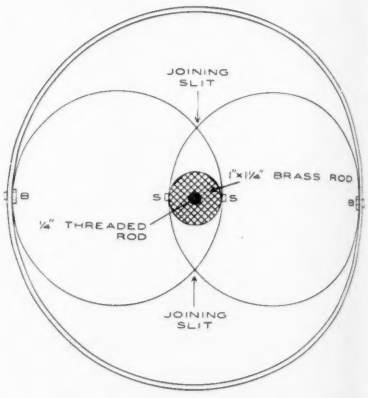
Next, take one of the rings and lay it off on the drawing so that one side touches the inner large circle and extends ½" beyond the center, with one of the straight lines through the center of the ring. Scribe the outside of this ring.



Each ring of the double-ring spider is slotted so that it can fit tightly into the other ring and to the tube wall.

Transfer the ring to the opposite side of the tube circle and scribe the place for the second ring. This will be a drawing of the complete system, showing where the rings are to be joined together and where they are to be fastened to the inside of the main tube.

Mark each ring at the two places where the other crosses it. Cut each slit halfway through the width of each ring, so



The spider gives firm support to a brass center piece, through which is bored a hole for the diagonal support adjusting rod, which holds an elliptical flat.

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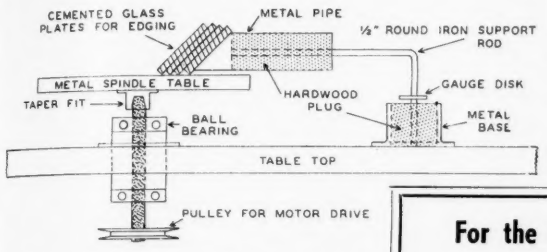
that they can be joined together to make one tightly fitted support no wider than either of them. Make sure that these slits are cut true to the drawing or working template.

After the rings are made to fit correctly, remove them and mark off the place where slots (**S**) are to be made, each to accommodate two 4-40 machine screws. These will have to be wider than the slits so as to take the thickness of the machine screws, and long enough to take two screws on either side of the center-drilled piece of 1″ round brass rod. The two outer slots (**B**) will take the ¼″ bolts fastening the whole assembly in the tube.



An arrangement for cutting the elliptical flat required for the double-ring support.

The 1″ round brass rod is drilled with a center hole to take the ¼″ brass rod, which is threaded and held fast with the two ¼-20 brass nuts, one above, the other below. This twin-nut system permits easy lowering and raising of the secondary without change in the position of the supporting rings.

Fasten the optical flat or diagonal into a brass tube of proper diameter that has been cut at a 45° angle. Into the tube insert a piece of hardwood, which will also have a 45° cut; against this the diagonal will rest. Into the other end of the hardwood plug fasten the ¼″ threaded brass rod.

The diagonal should, of course, come up to a high standard of flatness. Many articles have been written on how to finish a diagonal or a group of them worked at one time. Edging the diagonal to give an elliptical shape often presents difficulties, however. Inasmuch as an elliptical diagonal is a must with the double-ring support (diffraction past a square-ended prism or flat would cancel the gain of the double-ring system), I have included here a diagram showing a method of edging elliptical diagonals that practical experience has proven to be satisfactory.

The edging is done on a simple horizontally operated spindle, using a metal plate at least 8″ or 10″ in diameter, upon which the grinding grit is placed in the same manner as for grinding lenses or mirrors. As the diagram shows, nothing elaborate is needed for this operation, other than the spindle, which should have several speeds of rotation, and there should be a firm stand to support the glass during the operation.

Procure a piece of metal pipe, iron or soft steel, of the same outside diameter as the finished diagonal. One end of this pipe should be cut straight, the other to an accurate 45° bevel. To the beveled end is attached the glass for the diagonal, or several pieces (up to six) if they are to be done in one operation. If they are fastened with Chasers cement or Carnuba wax, they should hold together very well, unless too much strain is placed against them and the edging plate of the spindle. Therefore, care should be exercised at all times, as it is rather tedious to refasten the glass properly once the edging has been started.

Into the pipe upon which the glass is to be fastened insert a hardwood plug, flush with the straight end and extending almost up to the beveled end. This plug

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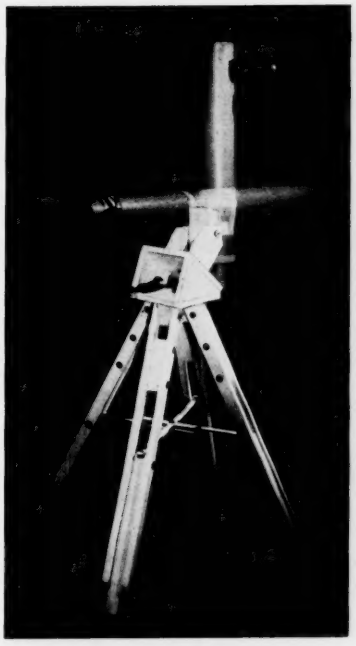

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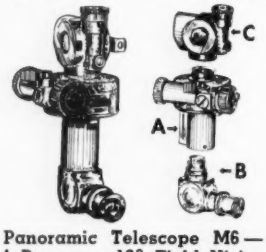

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should have a neatly drilled or bored hole of a diameter to take the support rod, which is mounted to the support base. The hole should be tight enough, yet free enough to rotate easily during the glass edging operation.

The support rod or bar is bent at right angles, one end bearing the pipe plug and the other end fitting another wooden plug in the base support. This method of support permits the operator to have command of the edging at all times, as the rod will swing with a radial motion and at the same time the pipe can be turned. The support rod should be fitted with a small metal ring, thick enough to take a small set screw; this will position the pipe each time it is lowered to have the glass meet the surface of the edging plate.

LEO N. SCHOENIG
825 Tripoli St.
Pittsburgh 12, Pa.

A Telescope Pier on a Concrete Driveway

THE NEED for a strong, rigid mount to take the place of a rickety tripod prompted this amateur to place his 4-inch refractor on a rigid support. However, I had no place to sink a durable concrete pier in the ground, nor did this seem necessary. I chose a suitable location on our cement driveway. It is well known that a large cement slab will reduce the vibrations caused by traffic, and it provides a smooth, dry, dew-free place from which to observe.

I had noted in many large machine shops that heavy equipment was anchored securely to cement by large lag screws with lead expanders. Even a machine that vibrated seemed to be held down securely by this method. I inquired as to how to install these lag screws, and was told to use a star chisel and a heavy hammer and slowly chisel away.

After seeing some high-pressure steam pipe, I chose the 4" size for the pedestal; any larger diameter pipe is too heavy and difficult to handle. But at a local pipe and steel company, I learned that new 4" pipe is over the price limit of most amateurs, including myself. But in the salvage yard, a 4½' length of used pipe was selected, and it was cut and threaded at both ends to fit two steam-fitting flanges. Other telescopes, depending on the kind and size, would take a different length of pipe; a reflector, for example, would probably use a shorter piece.

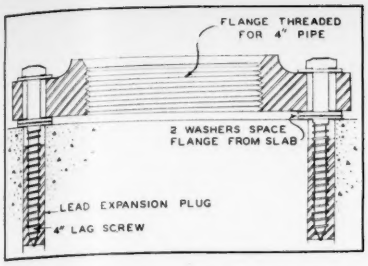
I had a hole drilled diametrically through the pipe to allow a piece of ½" pipe to fit through as a wrench. Without this device, unless you have a very large pipe wrench, you cannot get enough leverage to tighten the pipe to the flange on the cement.

Used pipe is usually rusted in some places and tarred in others. It is best to remove most or all foreign or loose matter and prepare the pipe for suitable paint primer.

The flange sets on two large steel washers, to permit water from rainfall or a sprinkler to run out free; otherwise, a serious case of rust and corrosion will develop. Any large hardware store has ¾" expanders made to fit ¾" holes. Merely hammer these expanders in gently until their tops are about ¼" or ½" below the surface of the cement.

When it is time to bolt the flange down to the cement and all the washers are in

Robert D. Smith, Jr., has mounted his 4-inch refractor on a pedestal set in the concrete of a driveway. The flange at the top of the pedestal is the same kind as that at the base, and holds an equatorial mounting by C. C. Young. The telescope is aligned by sighting on a small stick, on the roof of Mr. Smith's house, that is in line with true north. When the telescope and pedestal are removed, an automobile can be driven over the flange without damaging it or the tires. Photograph by Willard L. Groene.



Details of the manner in which the lower flange is fastened to the concrete of the driveway.

place, be sure to put some oil or grease on the screws. When the torque gets high it is very easy to twist a head off a screw, as I found from experience. However, a little lubrication will prevent this and insure the tight, firm fit that is required for this type of mount. Later, you can loosen the lag screws and place shims between the washers to align the pier so it points straight up. This is necessary only where the concrete has a slope in it.

Comments or suggestions from readers would be appreciated.

ROBERT D. SMITH, JR.
6635 N. Central Ave.
Phoenix, Ariz.

MIRROR GRINDING SUGGESTIONS

AMONG shortcuts used by professional opticians to produce better surfaces are the use of channeled grinding tools and the mixing of a detergent with abrasives for grinding.

The channeled grinding tool reduces sticking in the fine abrasives, and when this does occur, the worker can let a stream of water flow between the disks to loosen the dried grinding compound.

With this kind of tool, the air pocket does not form that usually tends to form at the center of the two disks, and which seems to cause drying there more rapidly than at the edge. This tool allows the two disks to assume a more spherical shape, and reduces the efforts of the worker to control the stroke so a uniform polish will take place after grinding is complete. The abrasives are distributed more regularly, the worn-out compound is carried away through the channels, and newer grains are supplied.

If one uses a spindle for roughing out mirrors, but has found that in the fine grades the danger of sticking is too great for this method of grinding, a channeled tool will eliminate the trouble. My first experience with such a tool was in the production of an f/10 8-inch pyrex mirror, produced on a rapidly rotating spindle designed for small lenses. Even an hour of hand grinding on each fine grade could not have produced the fine surface the machine and channeled tool did.

For mirrors of 10-inch size and larger, channels in the tool are a must if a good grind is to be obtained.

There are several methods of channeling tools by hand and by machine. For an amateur with limited facilities, a piece of brass about ⅛" wide (with a concave curve approximately that of the tool) can be rubbed between wooden guides with 220 abrasive until a groove about 1/16" deep is formed in the glass. Another method is to have the tool sandblasted, protecting the surface with squares of sandblaster's tape in a pattern similar to the squares of a pitch lap, and sandblasting between them.

If one has access to a diamond saw, the grooves can be cut with it; at least two cuts to a channel are recommended. The saw does not have to be very large for this purpose; a little investigation will enable members of a group to find a reasonably priced blade.

An easy out, and one that gives very satisfactory results, is to cement ceramic tile blocks to a glass or iron tool and grind on these. The principal problem here is to find a cement to hold the ceramics so they do not shift or come off; with modern cements a little experimenting should result in getting a satisfactory bond between tiles and tool.

Many telescope makers have in the past used glycerin with fine abrasives to help prevent drying out and sticking, but the average amateur uses plain water and takes his chances. A detergent acts as a vehicle to distribute the grinding powder better at the same time that it helps prevent drying out and sticking; it is especially good for machine work, the wets running longer. With a detergent, cleaning up around the tool afterward is easier, as the dried abrasives do not form so hard a powder.

There are a number of agents on the market suitable for this purpose, most with difficult names, but as good a material as any can be found right in your local grocery store. We had used Tide for cleaning lenses in our optical shop, and upon experimenting found that it can be added to the abrasives and will not scratch. It is mixed with water first and then some of this solution is poured into the pan of emery. It has been used with 304 emery without marring the perfection of the grind.

One word of caution: When applied with detergent even the finest abrasives seem noisy, but although one can hear the working action more clearly, experience has shown that the glass is not being scratched.

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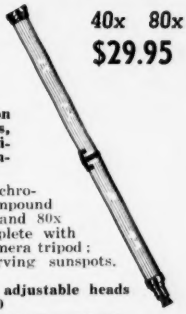

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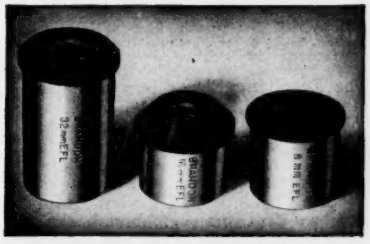

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OBSERVER'S PAGE

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Amateur Solar Eclipse Photography

IN MAKING PLANS for the total eclipse of the sun this June, one of the first thoughts of an amateur is photography. In planning my own expedition, I have found very little information on this subject readily available, but have gathered some data that may be of value to other amateurs. Part of the following discussion is based on a 1944 bulletin from the Eastman Kodak Co., entitled, "Solar Eclipse Photography for the Amateur." This bulletin is not, however, generally available, and was supplied to me by the company's Industrial Photographic Sales Division.

There are several different phenomena of the eclipse that invite photographic observations: partial phases, the shadow bands, the corona and prominences.

The Partial Phases. These must be the primary subject for eclipse photographers situated outside the narrow path of totality, but they offer a wider variety of picture possibilities than might be supposed. For instance, if most of the sun is obscured, the sunlit spots on the ground under trees take on crescent shapes. Similar crescents are formed by sunbeams that filter through window blinds and other "pinhole" openings.

An interesting series may be made of the partially eclipsed sun, by placing several exposures in sequence on the same film. The separation of the solar images and the angular width of the field determine the number of such exposures that can be included in one picture. Roughly, the sun moves one degree for each four minutes of time, and its own diameter is about half a degree. With a fixed camera, an exposure every five or six minutes will show images sufficiently separated from each other. For series shots of this kind, a camera back that accommodates ground glass is invaluable; the positions of the solar images can be marked on the glass in advance. Reflex cameras are also useful for positioning each image.

The sun is a very bright light source, with practically the same brightness over its whole surface, except very near the limb. Therefore, although the total amount of light reaching the earth varies during the partial phases, the surface brightness of the part of the sun being photographed does not change appreciably. The same exposure time should be used all through the series.

Also, because the brightness of the sun's surface is nearly uniform, test exposures at varying apertures and shutter speeds can be made in advance on any clear day. [Tests on hazy or foggy days may be valuable, too, in the event you have that kind of eclipse weather.—ED.]

From an observation point outside but near the path of totality, the apparent rotation of the crescent sun about the moon is interesting. At the height of the eclipse, the bright crescent will appear to turn rapidly through nearly 180 degrees. Probably the most satisfactory way to photograph this will be with a motion-picture camera and a telephoto lens, using a filter.

Filters. Warning! Fires are started by the sun through burning glasses, and a camera lens is a good burning glass. Protection is essential for your ground glass, shutter, or diaphragm while focusing or making the exposure. Also, **never** look at the sun directly with the naked eye, except just before and during totality.

Filters give the needed protection if they are dense enough. It is true that the sun can be photographed directly without a filter, with an exposure of 1/1,000 second at f/64 on medium-fast film. But few photographers have such rapid shutters and small apertures on their regular equipment. Glass filters are best; they should be dense, or a combination of red and green, possibly with crossed polaroids. I have had pretty good results at f/11 or f/8 and 1/50 second on Super-XX film with a filter made from a completely exposed and developed lantern slide. A Brownie box camera and a piece of blackened film will probably give about the same result.

Shadow Bands. During the last minute or so before totality and immediately after, shadow bands are sometimes seen. These are dark bands some inches wide and about a foot apart, traveling over the ground at rather high speed. They are usually observed as shadowy waves on light-colored surfaces, but they are difficult to photograph because of the speed with which they move, and the low illumination at the time. Use a sheet or other light surface as a background, and try to catch the bands with as fast a film as possible at a shutter speed of approximately 1/100 second; the lens opening should be f/1.9 or as large as possible.

Corona and Prominences. The corona surrounding the totally eclipsed sun is the most beautiful of the phenomena associated with the eclipse. Inside the path of totality, the observer will probably concentrate his efforts on this. The corona may extend outward for several solar diameters, with ever-decreasing intensity, and if the outer corona appears on a photograph the inner parts will probably be badly overexposed. Therefore, several different exposures will be required for a complete record of the corona.

The Eastman Kodak bulletin recommends: Verichrome, Plus X, and other films of speeds about 50 (American standard exposure index), with f/8 lens stop and no filter, 1/25 second for prominences, ½ second for the inner corona, and 3 seconds for the outer corona. For Daylight Kodachrome use f/5.6 at 1/30 second for prominences, f/10 at 1 second for the inner corona, and f/3.5 at 4 seconds for the outer corona; double these times for Ektachrome Daylight. Use the foregoing suggestions as bases for calculating proper exposures with other emulsions and apertures.

Movies on black-and-white film will probably require an aperture as fast as f/7 for the prominences, and a wide-open lens with film speeds of about 50 for the

The arrows show the location of the galaxy NGC 2149 in this finding chart reproduced from the Ross-Calvert "Atlas of the Northern Milky Way." North is above, and the very bright star near the right edge is Kappa Orionis. The approximate scale of this photograph is one degree per inch.

corona. At least f/5.6 will be needed for Kodachrome movies of the prominences.

Images will be trailed at exposures longer than one second, perhaps even if longer than ½ second. Cameras can be mounted equatorially with clock drives, or in some other way made to follow the sun. A heliostat or coelostat may be used to reflect sunlight continuously into a stationary camera.

Size of Image. To a close approximation, the diameter of the sun's image will be 1/100 of the focal length of the lens used. Thus a lens of five inches focus will give an image only 1/20 inch across. For this reason fine-grain film is desirable, and care must be taken in development to preserve the fine grain so that enlargements will be possible.

To obtain a large image, use a lens of long focal length. Telephoto lenses may be helpful, or the camera can be used in conjunction with a telescope. Camera and telescope must be mounted together rigidly, and the focus of both must be carefully adjusted so that the image on the film is sharp. The camera may be used without its lens, its film placed in the focal plane of the telescope, or the telescope image may be enlarged by projection through an eyepiece. Then the camera and the telescope must be focused for infinity before mounting them together. If such a combination is used, a series of test exposures on the sun and moon must be made before eclipse time to assure proper focus and exposure times.

Plan your eclipse program in advance. There won't be time for many exposure-meter readings and adjustments in less than 1½ precious minutes of totality!

D. C. WHITMARSH
1152 S. Atherton St.
State College, Pa.

DEEP-SKY WONDERS

WHAT HAVE been called "nebulae" in the past actually include five very different major types of objects. This month we list an example of each for the observer who likes a mixed bag. Our **planetary** is NGC 1952, M1, better known as the Crab nebula, at $5^h\ 31^m.5$, $+21°\ 59'$. A "show object," it is 6′ x 4′. Its discovery by Messier in 1758 led him to compile his famous catalogue. Probably the result of a supernova in 1054 A.D., the object is possibly not a true planetary (**Sky and Telescope,** October, 1942). The outstanding **gaseous nebula** of this season is NGC 1976, M42, visible to the naked eye as θ Orionis, at $5^h\ 32^m.9$, $-5°\ 25'$, the greatest show in the heavens (**Sky and Telescope,** June, 1952). With M43, this is more popularly known as the Orion nebula. **Globular clusters** are rare in the winter sky, but NGC 1904, $5^h\ 22^m.2$, $-24°\ 34'$, in Lepus is one of these rarities. Out of 101 globulars, only 11 fall within the first 12 hours of right ascension. NGC 1904 is 3′.2 in diameter, and is bright enough to have been recorded by Messier as M79.

Galactic clusters are legion in the winter Milky Way, and NGC 2099, M37, $5^h\ 49^m.0$, $+32°\ 33'$, is a brilliant sprawling cluster in Auriga, easy to locate and impressive in any telescope. Because of obscuring clouds near the central plane of our Milky Way system, spiral nebulae or **galaxies** are rare around 4^h and 5^h right ascension, but NGC 2149, $6^h\ 01^m.1$, $-9°\ 44'$, peers through a somewhat transparent hole in the dust. Small and faint, it is only magnitude 12.6, and presents a "finding" challenge that will test the skill of even the most veteran observer. It does show up clearly on Plate 34 of the Ross **Atlas,** of which part is reproduced here as a finder chart. WALTER SCOTT HOUSTON

MOON PHASES AND DISTANCE

New moon	February	3, 15:55
First quarter	February	10, 08:29
Full moon	February	17, 19:17
Last quarter	February	25, 23:29
New moon	March	5, 03:11

	February		Distance	Diameter	
Perigee	6,	6^h	226,600 mi.	32′	46″
Apogee	22,	7^h	251,900 mi.	29′	28″
	March				
Perigee	6,	10^h	223,500 mi.	33′	14″

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SUNSPOT NUMBERS

The Solar Division of the American Association of Variable Star Observers has compiled the American sunspot numbers (**A**) listed here, beginning in July, 1953; and Dr. M. Waldmeier, of the Swiss Federal Observatory, has supplied the Zurich numbers (**Z**) for October and November, based on observations at Zurich, Locarno, and Arosa.

1953	July	Aug.	Sept.	Oct.		Nov.
	A	A	A	A	Z	Z
1	0	0	2	0	0	12
2	4	5	0	0	0	11
3	0	13	0	4	7	10
4	0	16	0	3	7	9
5	0	14	1	1	0	0
6	0	11	12	19	13	0
7	0	12	14	18	13	0
8	0	25	16	15	14	0
9	8	32	17	17	11	0
10	15	55	18	6	10	0
11	15	72	19	8	9	0
12	17	66	28	13	9	0
13	17	67	20	18	8	0
14	24	60	27	29	29	0
15	21	52	44	24	22	0
16	17	55	44	18	13	0
17	17	43	40	4	9	0
18	16	36	38	0	0	0
19	13	31	20	0	0	0
20	11	18	20	0	0	0
21	4	14	15	0	7	0
22	0	14	14	0	0	0
23	0	3	11	1	0	0
24	0	0	13	0	7	0
25	0	0	18	0	7	0
26	0	0	16	13	12	0
27	0	1	2	4	7	0
28	0	1	0	0	7	0
29	0	0	0	0	0	0
30	0	0	3	0	0	0
31	0	0	—	7	8	—
Mean	6.4	23.1	15.7	7.2	7.4	1.4

Zurich predictions of the smoothed relative sunspot numbers for the following months are: January, 10; February, 9; March, 8; April, 7; May, 6.

Dr. Waldmeier advises that the Swiss Broadcasting Corporation carries on a regular schedule of broadcasting relative sunspot numbers for the preceding month, as follows (effective through April): To North America, on the 5th of each month, at 01:35 and 03:20 UT, on 48.66, 41.61, and 31.46 meters wave length. Broadcasts to England and Ireland are on the 4th of each month, at 18:50 UT, on 49.55 and 31.04 meters; to South America on the 4th at 23:30 UT, on the 5th at 00:45 UT, on 41.61, 31.46, and 25.28 meters. Australia, the Far East, and New Zealand are scheduled for the 5th at 07:20 and 09:05 UT, on 25.28, 19.60, and 16.87 meters; these same wave lengths are used for Southeast Asia and Japan, on the 5th at 12:50 UT; and for India, Pakistan, and South Africa, on the 5th at 14:50 UT.

THE INDEX TO VOLUME XII appeared in the October *Sky and Telescope*. Indexes to Volumes I through IX are available, at 35 cents each postpaid. The indexes for Volumes X and XI are included in the issues of October, 1951 and 1952, respectively.

BINDERS

for *Sky and Telescope* are available. These are of the loose-leaf type, in which each issue may be filed as it is received. Covered with dark blue fabrikoid, the binders may be reused from year to year or kept as permanent binding for separate volumes. Each binder costs $3.50 postpaid in the United States, $4.00 in Canada. No orders from foreign countries can be accepted. Your name can be gold-stamped for 70 cents extra, the volume number for 40 cents, both for $1.00; print desired lettering clearly. Payment must accompany your order.

SKY PUBLISHING CORPORATION

VARIABLE STAR MAXIMA

February 9, RS Scorpii, 164844, 6.8; 9, U Cygni, 201647, 7.6; 10, RS Cygni, 200938, 7.4; 12, S Carinae, 100661, 5.7; 23, S Hydrae, 084803, 7.9; 24, RR Scorpii, 165030, 6.0; 27, R Caeli, 043738, 8.0. March 6, Chi Cygni, 194632, 5.3; 7, R Normae, 152849, 7.2.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

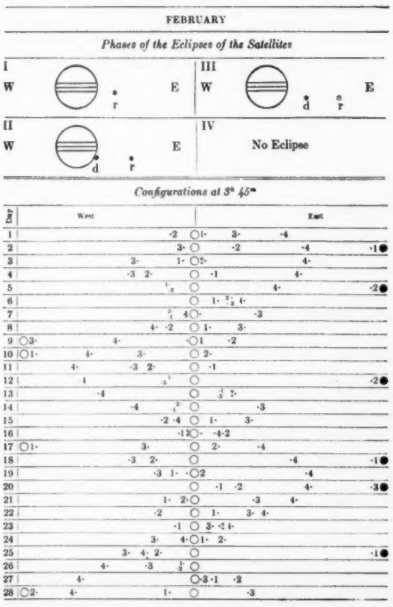
MINIMA OF ALGOL

February 3, 17:12; 6, 14:01; 9, 10:51; 12, 7:40; 15, 4:29; 18, 1:19; 20, 22:09; 23, 18:58; 26, 15:48. March 1, 12:37.

These minima predictions for Algol are based on the formula in the 1953 **International Supplement** of the Cracow Observatory. The times given are geocentric; they can be compared directly with observation.

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the American Ephemeris and Nautical Almanac.



PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Juno, 3, 8.2. Jan. 18, 9:30.0 +1-05; 28, 9:22.4 +2-17. Feb. 7, 9:13.7 +3-49; 17, 9:05.4 +5-32; 27, 8:58.6 +7-15.

Pallas, 2, 6.8. (Note: A chart of Pallas' path was published in the December issue.) Jan. 18, 9:49.3 −22-51; 28, 9:44.4 −21-12. Feb. 7, 9:37.6 −18-37; 17, 9:30.4 −15-08; 27, 9:23.9 −11-00. Mar. 9, 9:19.3 −6-32.

Eleonora, 354, 9.3. Jan. 18, 10:00.1 +18-05; 28, 9:54.9 +11-55. Feb. 7, 9:48.0 +13-59; 17, 9:40.3 +16-07; 27, 9:32.9 +18-00. Mar. 9, 9:26.8 +19-51.

Astraea, 5, 8.7. Jan. 28, 10:35.7 +9-11. Feb. 7, 10:30.4 +10-23; 17, 10:23.1 +11-46; 27, 10:15.1 +13-07. Mar. 9, 10:07.8 +14-23; 19, 10:02.4 +15-20.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1954.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

A sheet giving bright minor planet positions for 1954 will be mailed on request to the Cincinnati Observatory, Observatory Place, Cincinnati 8, Ohio. Enclose a self-addressed stamped envelope.

OCCULTATION PREDICTIONS

February 9-10 **Epsilon Arietis** m 4.6, 2:56.6 +21-09.5, 6, Im: **A** 4:10.9 +0.3 −2.5 127; **B** 4:04.3 +0.1 −2.1 117; **C** 4:26.5 ... ... 154; **D** 4:09.5 +0.2 −2.9 131; **I** 3:19.0 −1.7 −2.7 124.

February 10-11 **Eta Tauri** 3.0, 3:44.7 +23-57.9, 7, Im: **B** 22:15.7 −1.1 +2.6 37. Em: **A** 23:23.1 −2.1 −0.5 280; **B** 23:18.4 −2.1 −1.1 292; **C** 23:14.1 −2.2 +0.1 270; **D** 23:07.7 −2.2 −0.7 290.

February 10-11 **27 Tauri** m 3.8, 3:46.4 +23-54.9, 7, Im: **A** 22:59.7 −1.9 +0.4 83; **B** 22:59.5 −1.7 +0.8 72; **C** 22:49.0 −2.1 +0.3 89; **D** 22:48.0 −1.6 +1.1 73.

February 10-11 **28 Tauri** 5.2, 3:46.4 +23-59.9, 7, Im: **A** 23:03.7 −1.8 +1.1 66; **B** 23:05.9 −1.5 +1.5 55; **C** 22:51.4 −1.9 +1.0 74; **D** 22:54.1 −1.5 +1.7 56.

February 10-11 **BD +24°599** 6.4, 3:54.7 +24-19.8, 7, Im: **A** 3:40.1 −1.2 +0.3 46; **B** 3:40.6 −1.3 +0.9 35; **C** 3:34.8 −1.2 −0.3 65; **D** 3:31.9 −1.3 +0.3 50; **E** 3:15.7 −1.6 −0.3 72; **F** 3:11.8 −1.9 −1.6 108; **H** 2:18.9 −2.2 +0.4 84; **I** 2:33.1 −1.2 +2.7 33.

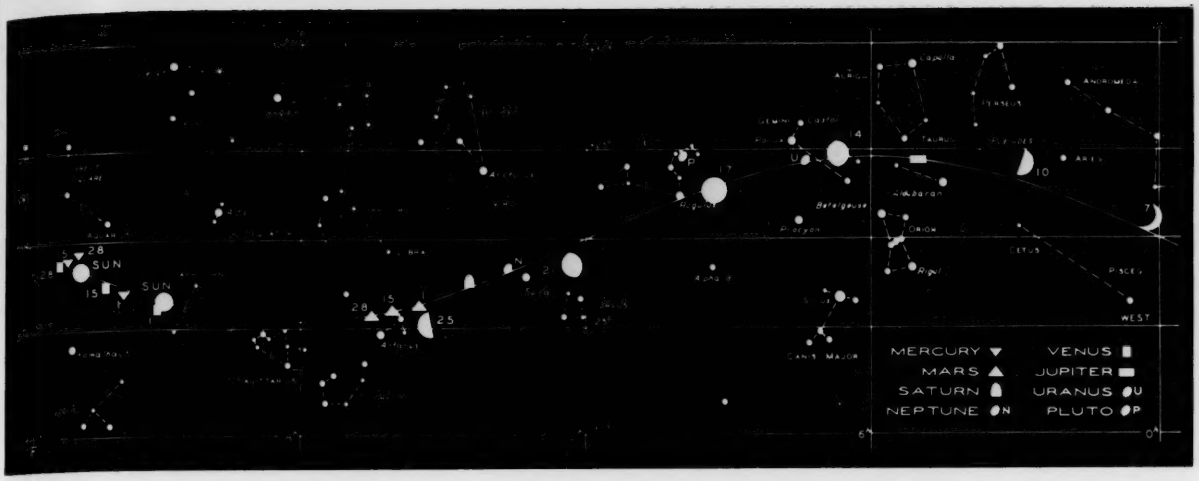
February 24-25 **A Scorpii** 4.8, 15:50.8 −25-11.5, 22, Em: **F** 12:02.0 −3.0 +0.7 250.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, **data from the American Ephemeris and the British Nautical Almanac are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.**

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury attains eastern elongation on February 13th, 18° 09′ from the sun. The "elusive planet" will not be difficult to view around this time as it sets 1½ hours after the sun, descending at a steep angle to the horizon for observers in north latitudes. Its magnitude will be −0.3. Mercury may be seen with the naked eye as early as the 5th, setting an hour after the sun and at magnitude −0.9.

Venus will be too close to the sun in the evening sky to be seen.

Mars continues as a morning star, rising over five hours before the sun. Its declination will be south of −20° from the 16th of this month until November, and thus Mars will be poorly situated for observers in the Northern Hemisphere. On the 25th, Mars passes 5½° north of Antares, and at magnitude +0.9 it will be slightly brighter than the star. Comparison of these reddish objects may be interesting. The disk of Mars is 6″.7 in diameter on the 15th, and it is summer in the Martian northern hemisphere.

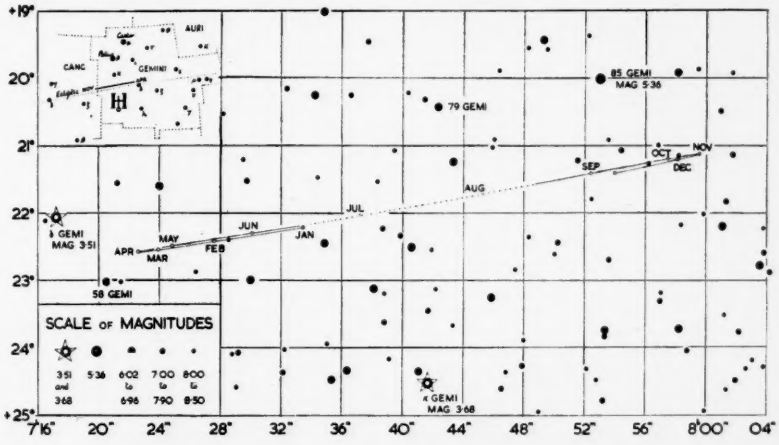
Jupiter, visible till about 3 a.m., continues to dominate the evening sky. Located halfway between Alpha and Beta Tauri, the planet resumes eastward motion on the 10th. On the 15th its stellar magnitude is −2.0, and its disk is 42″ in equatorial diameter.

Saturn rises at midnight, appearing at magnitude +0.7, in Libra. Retrograde motion commences on the 18th, preceding opposition in April. The famed ring system appears inclined 18°.9 to our line of sight on the 15th, with a longest diameter of 39″.6.

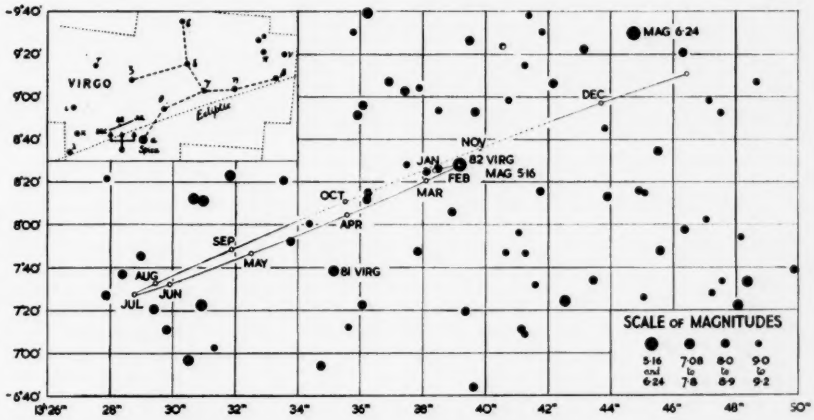
Uranus remains above the horizon till dawn and can be viewed with slight optical aid. The planet continues in retrograde motion, about 2° east of Delta Geminorum.

Neptune appears above the horizon shortly before midnight and may be found in Virgo with the aid of binoculars. This 8th-magnitude object is slowly retrograding, less than a quarter of a degree west of 82 Virginis.

Pluto comes to opposition with the sun on February 12th, located about halfway between Epsilon and Zeta Leonis. Its position on that date is $9^h\ 58^m\ 43^s$, +23° 06′.1 (1950), and it will then be moving 6ˢ west and 0′.6 north per day. Its magnitude is between 14 and 15. E. O.



The path of Uranus among the stars in Gemini and Cancer is shown above; that for Neptune among the stars in Virgo, below. In each case the field is inverted, with south at the top, as seen in an astronomical inverting telescope. The scales of the two charts are not the same. From the 1954 "Handbook" of the British Astronomical Association.



UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

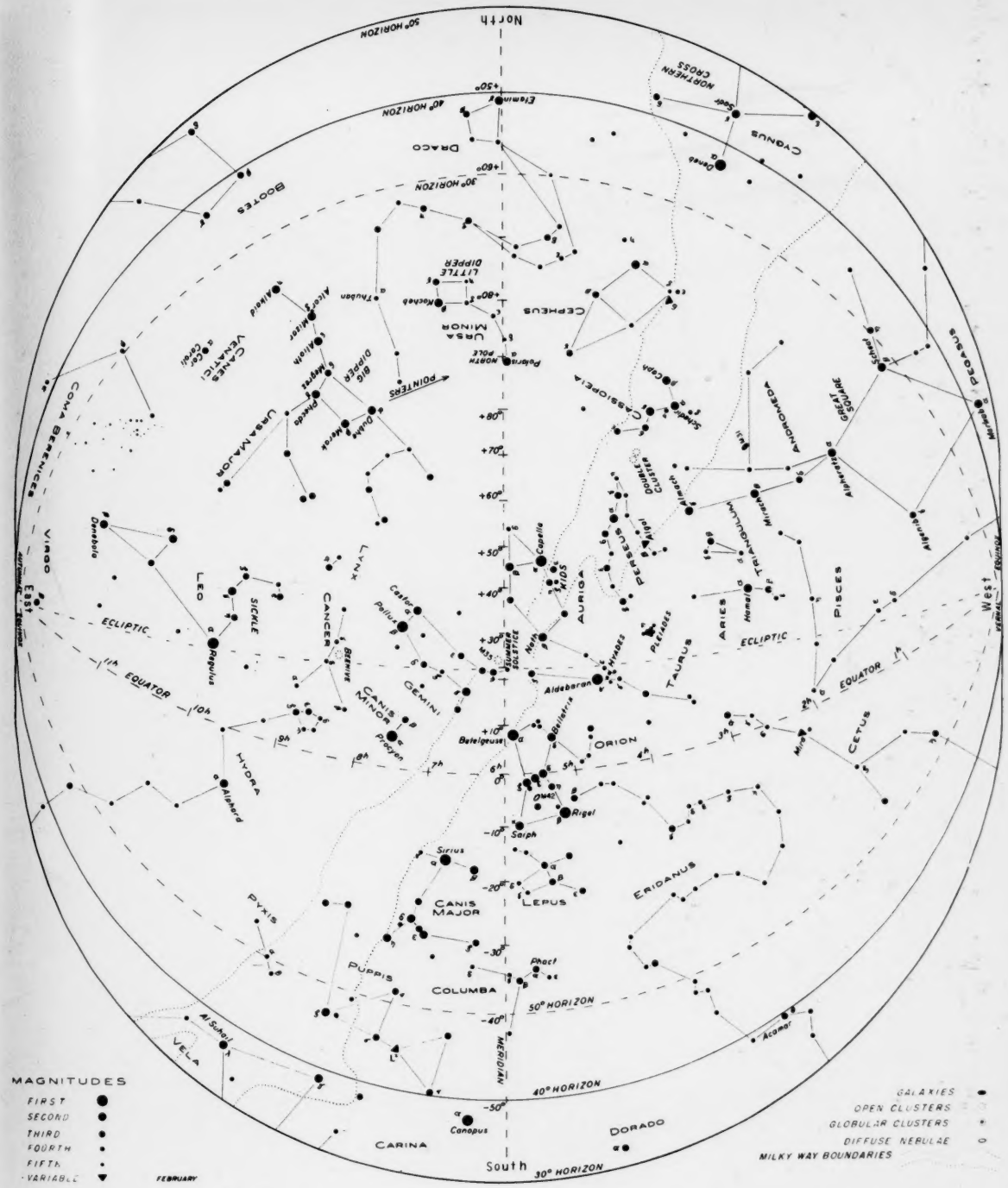
The sky as seen from latitudes 20° to 40° south, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of May, respectively.

SOUTHERN STARS

VERY CLOSE to the meridian at our chart times this month is the Southern Cross, now standing upright, and the nearby Coalsack, singled out for discussion two months ago. The Milky Way that surrounds them stretches across the sky.

High in the east and next to the Southern Cross stands Centaurus. This constellation, apart from Orion, is the only one to claim two stars brighter than magnitude 1.0. Alpha Centauri is one of the most remarkable stars in the sky, a splendid double star in even small telescopes. Its two components are magnitudes 0.3 and 1.7, and they are now eight seconds of arc apart. Beta Centauri is magnitude 0.86.

Between Gamma and Zeta Centauri, and a little closer to the latter, is the great globular star cluster Omega Centauri. To the naked-eye observer it appears as a hazy star of the 4th or 5th magnitude. The first man to view it through a powerful telescope was Sir John Herschel, when he surveyed the southern skies with an 18-inch reflector in the 1830's. His written record, "most glorious object . . . truly astonishing," indicates the impression made by this great swarm of many thousands of closely packed stars, when photographed or seen with a telescope of great light-gathering power.



The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of February, respectively.

STARS FOR FEBRUARY

IN THE early evenings of February, Ursa Major, the Great Bear, again stands well up the northeastern sky. Since autumn it has been relatively inconspicuous below the north pole of the heavens, at our chart times, and its return to prominence is a harbinger of spring.

Reaching from the eastern horizon halfway up the sky is Leo, the Lion. His head and forequarters are marked by a sickle-shaped group of stars, in whose handle is the 1st-magnitude star Regulus.

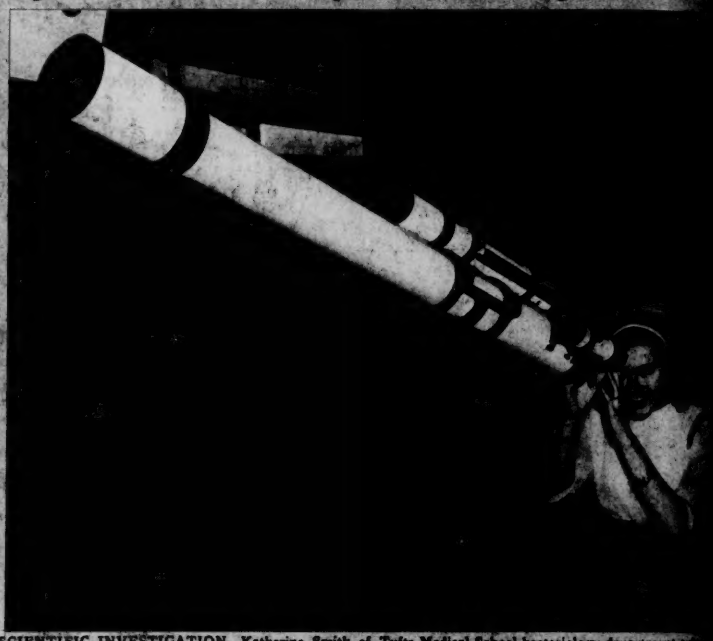
In the southern sky bright Sirius is now favorably placed near the meridian. Compare its appearance with that of the planet Jupiter, conspicuous as an even brighter object, now considerably higher in the sky between Aldebaran and Gemini. The color contrast is marked: Sirius is nearly pure white, and Jupiter shines with a soft golden glow. Notice also that although the twinkling of Sirius may be quite marked, Jupiter does not twinkle. This is because the disk of Jupiter, large enough to be recognized in an opera glass, twinkles not as a whole but by parts; and for the naked-eye observer, who sees only the combined light of these parts, their fluctuations in brightness average out. A star's apparent disk is very much smaller, and so this averaging does not occur.

The rewarding but unfamiliar constellations of Lepus, Columba, Canis Major, and Puppis are grouped below Sirius. Observers who live in latitudes less than 35° north should now look for Canopus.

THE BOSTON DAILY GLOBE—TUESDAY, DECEMBER 29, 1953

News and Views of 120th Meeting of AAAS in Bos

Scientific Exhibits Attract Throngs at Mechanics Building; Study New England Econ



SCIENTIFIC INVESTIGATION—Katherine Smith of Tufts Medical School bacteriology department ... through a Unitron, four-inch photographic equatorial telescope.

OUR 4-INCH EQUATORIAL REFRACTOR was a dominating feature of the exhibit area. Photographs of the instrument appeared in the Boston **Globe** (reproduced here), on the front page of the Boston **Traveler,** and in the Boston **Herald.**

...oto by Ed Keller, Globe Staff)
...—Lt Donald Thomp... about the Aerobee re... gear for research in ...rt of the Air Force ... A. A. S. meeting.

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Special TV Peers Into Strain on Heart

Now they've developed a television set to help people avoid heart attacks.

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Over 40's And Arteries

Trying to Get Ahead Breeds Hea...

It's the person over 40 who ... tries too hard to get ahead amid the difficulties of the fast pace of modern life who is most like... to have heart attacks, a Chic... ...ician told psychologist... the A. A. ...

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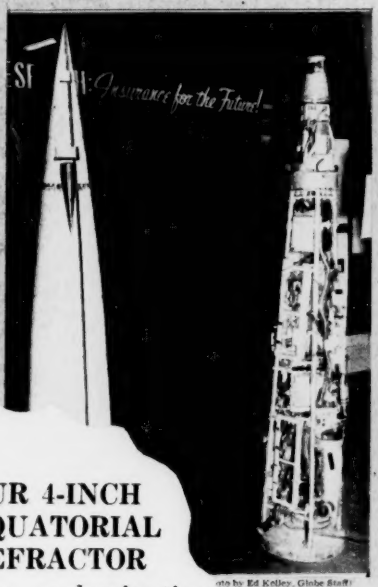
News and Views of 120th Meeting of AAAS in Boston

Scientific Exhibits Attract Throngs at Mechanics Building; Study New England Economy



to by Ed Kelley, Globe Staff
—Lt Donald Thomp-
about the Aerobee re-
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Introduce Subject in Natural Manner

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